Offshore Diving First Aid

Course Manual






TRAUMA TRAINING

Contents

The Aim Of First Aid 1.1

Preserve Life

Not only the casualty's life, but your own as well. Far too often only one person's life is in danger when the emergency services are called, but by the time they arrive there are more. If you put your life in danger, you can end up fighting for your OWN life instead of the casualty's.

Prevent the situation from Worsening

The skilled first aider must take action to prevent the whole situation from becoming worse *(e.g. removing dangers such as traffic or fumes),* as well as acting to prevent the casualty's condition from deteriorating.

Promote Recovery

The actions of a first aider should, after preventing things from getting worse, help the casualty to recover from their illness or injury.
First aid is what it says – the immediate help given to a casualty after an incident to prevent something becoming more serious. Simply by applying first aid skills you can often prevent something becoming more serious – for example helping someone who is choking, stopping bleeding, helping with an asthma attack, putting someone in the recovery position.

The main philosophy of First Aid is the S.A.V.E.S. principle:

- **S**imple
- **A**ctions
- **V**ery
- **E**arly
- **S**aves Lives

Managing The Scene 1.2

In pre-hospital care, when dealing with all emergency situations, it is just as essential to be able to draw conclusions from your observations at the accident scene. Therefore, an understanding of the forces involved and patterns of injury is essential if injuries, which may be life threatening, are not to be missed.
This forms the basis of scene assessment.

Scene Assessment

The history of the incident begins at, for example, at the point of impact of one moving object with a second object. That second object may be either moving itself or it may be immobile. We must understand the exchange of energy that takes place, the direction of the forces involved and therefore recognize the extent of injuries that may be caused by an accident.

Obviously we must know the details of the accident: who hit what and at what speed and any mechanisms involved in restraining or protecting the individual. Understanding the energy exchange, which takes place and by answering these questions, the rescuer may be able to predict the injuries the accident victim may have sustained. As a general rule of thumb, if an incident involves sudden cessation of high velocity the chances of injury are high.

Along with high energy incidents are injures which have gross physiological effects.

This is why it is very important to be **highly** suspicious of certain types of incidents, which involve:

- Falls (2-3 times victim's height).
- Craft collisions.
- Unresponsive or altered mental status.
- Near-Drowning.
- Penetrating Injuries (head, chest, abdomen).

It is worth remembering that it maybe true that the incident began at the point of impact, but behind this point in time lays information, which may have a bearing on the patient.

An example of this would be a casualty who has fallen off a structure. On initial assessment, the cause of his injuries appears to be attributed to the impact of falling 10 feet, where in fact, the pre-events have major impact upon his outcome. If this were to be ignored, the casualties pre-existing diabetic hypoglycaemic event maybe missed.

So, when assessing the scene, look for pre-incident clues and post-incident clues.

Approaching A Casualty 1.3

Safety in the First Aid situation is of paramount importance.

You are responsible for the safety of:

- 1st – yourself
- 2nd – the scene
- 3rd – the patient(s)

Hazards/dangers that may exist at a scene may include:

- Water.
- Moving craft.
- Fire.
- Electricity.
- Chemicals.
- Fuel spillage.
- The weather!

Safety can be seen to have four dimensions:

- Left and right
- Up and down
- Front and back
- And the 4th dimension…….. Time:

Always be alert for dangers, which may have caused the incident or have resulted from the incident. Safety assessment is time dynamic. As the scene changes safety risks may appear and disappear (for example fires may be extinguished but the slippery deck may become more relevant). It is therefore important to ensure that safety appreciation is updated frequently and not confined to the single assessment at the beginning of the rescue.

A Systematic Approach to Casualty Management 1.4

As discussed the main principles of First Aid are to:

- Preserve Life
- Prevent the situation from Worsening
- Promote Recovery

It is important to achieve these goals in as efficient fashion as possible. It is for this reason that a systematic approach to **EVERY** casualty should be implemented. This systematic approach has 7 main principle elements, which are:

- Calling for help **Early**.
- **Rapid** 'Quick Look' Primary Assessment.
- **Treat life-threatening** problems as you assess.
- **Assess** effects of treatment.
- **Systematic** Secondary Assessment.
- Definitive **Treatment** / Decision to **Evacuate**
- **Reassessment**

The Casualty Management Process

S.A.F.E. Approach 1.4.1

With regards to safety it is advisable to always use a SAFE approach:

S: Shout for help

A: Assess the scene

F: Free from danger

E: Evaluate the casualty

The SAFE approach is a vital step in overall safety, both to the casualty & his potential rescuers.
The first element of the approach is **S**houting for help, it is very rare that a first aider alone can actually provide definitive care, so alerting fellow bystanders can give a first aider a vital life-line to alerting medical services while they give potentially life-saving initial treatment.

Secondly we **A**ssess the environment for potential or actual dangers. Once they are eliminated or reduced to an acceptable level, the first aider may approach the casualty. It is important to recognize that sometimes it it impossible to actually achieve this in sufficient time for a casualty to actually survive. A classic example is of a casualty in contact with a high voltage electrical supply, the power MUST be switched off before a rescuer can approach the casualty. If this is not achieved then the only result will be an increase in the number of casualties & the number of people needing treatment.

Thirdly we **F**ree the casualty from danger. If an environment can-not be made safe then an attempt to remove the victim to a safer area may be attempted. It is important to note that a degree of judgment is needed & any movement must be beneficial to a casualty. For example, if a casualty is in the water, they must be extracted before effective resuscitation can be administered.

Lastly we can **E**valuate. This is a natural progression onto our Quick Look Primary Survey & Secondary Survey. Which will be discussed next.

'Quick Look' Primary Survey 1.4.2

An assessment of the casualty begins as the First Aider approaches the casualty. Talk to the casualty. Introduce yourself and reassure them that help is at hand. Ask the individual, and/or bystanders, what has happened. If the patient verbally responds to voice commands this tells you, in gross assessment terms, that the patient has an airway, is breathing and has a blood pressure strong enough to adequately perfuse the brain. Remembering that this is an *initial assessment* and their status may change at any moment.

The Primary Survey

Often the cause may seem obvious, for example, a lying ladder suggests a possible fall from a height, whilst at other times the answers you get could provide vital clues to the diagnosis. Remember, the casualty may have more than one injury.

This "quick look" should only take a few seconds as you approach the casualty.

A systematic approach to the Quick Look Primary Survey is:

- Looks : Colour, demeanor, surrounding circumstances.
- Can casualty complete a full sentence? A.B.C.D. Implications
- Immediate impression.
- Consider Provisional Triage Category

As with every element of the first aid approach, life-threatening injuries should be dealt with as they are discovered. With regards to triage categorization, this is particularly relevant if there are numerous casualties with a finite amount of first aiders for establishing treatment priorities & evacuations. Triage categories established in the rapid Quick Look approach are provisional & may be corrected once the casualty is properly assessed.

Secondary Survey 1.4.3

The purpose of a Secondary Survey is to provide a systematic approach to the assessment of any casualty. The assessment follows an A,B,C,D & E approach. Which stands for:

- **A**IRWAY
- **B**REATHING
- **C**IRCULATION
- **D**ISABILITY
- **E**XPOSURE

This approach is a well-established 'gold standard' approach used in all branches of medical care WORLDWIDE.
This approach should be applied with a set of simple rules:

- Be Systematic. A➔B➔C➔D➔E
- Treat Illnesses as they are discovered.
- Once an intervention is made. Reassess.
- Seek help early.
- Reassess

There is a very good why this technique is employed by all branches of medicine worldwide. IT WORKS !

A: Airway 1.4.3.1

Can the casualty talk? If the patient is *silent* or has a *noisy* airway then the airway should be checked for patency to

ensure that it is open and clear that there is no potential for obstruction to occur.

The most common cause of upper airway obstruction is an altered level of consciousness and pharyngeal obstruction by the tongue. Left unmanaged, airway obstruction may lead to hypoxia (lack of oxygen) and ultimately death.

Once an airway is opened and secured it must be maintained. If the airway is compromised then it will have to be opened and cleared. Obviously this must be done initially without moving the neck. However if it is not possible to open the airway without some movement of the cervical spine then the airway assumes the greater priority.

The Airway

Airway obstruction can occur from many causes ranging from the position of the tongue, injuries or the presence of an obstruction within the mouth or Air passage to the lungs (perhaps after inhalation, vomiting or regurgitation) or larynx or upper part of the trachea (foreign bodies, epiglottitis, allergic reactions or laryngo-tracheal injuries).

The Airway should be assessed using a Look, Listen & Feel approach.

LOOK: Inspect the mouth for any foreign bodies and remove anything obvious. DO NOT PERFORM BLIND FINGER SWEEPS. Well-fitting dentures may be left in place. Check the upper airway for any vomit, blood or secretions.

Observe the pattern of breathing; where complete airway obstruction has occurred, a seesaw pattern of breathing will be evident – paradoxical chest and abdominal movements. A clear airway enables the chest and abdomen to move outwards during inspiration, and inwards during expiration. 'Seesawing' results in the chest moving outwards on inspiration whilst the abdomen moves inwards. Other accessory muscles such as chest muscles and abdominal musculature may be used.

LISTEN: for any added sounds, which may indicate airway problems such as:

- **Snoring**: pharyngeal obstruction by the tongue.
- **Crowing**: laryngeal spasm.
- **Gurgling**: fluids in the upper airway.
- **Stridor**: obstruction of the upper airway.

FEEL: for air movement, either by placing the back of your hand or side of your face over the mouth of the patient. This will enable you to determine whether or not the airway is obstructed.

B: Breathing 1.4.3.2

Hypoxia is life threatening and therefore the state of the patient's ventilation and whether that ventilation is adequate is our next priority. If there is no spontaneous respiration or ventilation is inadequate then you must provide ventilatory support. The respiratory rate must be counted.

Assessment of Breathing is performed using the Look, Listen & Feel approach.

LOOK: Count the respiratory rate. Normal resting respiratory rate is between 12 and 20 breaths per minute. Alterations in respiratory rate are an early and sensitive indicator of developing illness; rising rates are a very early sign of developing illness. The rate may slow down appropriately in response to treatment, however, where the underlying problem has not been corrected, slowing rates may be indicative of impending respiratory arrest and the actual respiratory rates must always be considered within context of the situation.

Look for any evidence of respiratory distress and increased work of breathing. Is the patient using their accessory muscles? Abdominal distension may inhibit respiratory function. Check that both sides of the chest are moving equally. Unilateral chest movement may indicate pleural effusion, pneumonia or pneumothorax. Does the casualty appear to be experiencing severe pain, which will inhibit respiratory function?

Breathing Assessment

Important visual clues to the adequacy of breathing include the following:

- Breathing Rate.
- Sweating.
- Central cyanosis.
- Use of the accessory muscles of respiration.
- Abdominal breathing.
- Depth of each breath.
- Equality of chest movement on each side.

LISTEN: To the patient's response to communication, is the patient orientated, do they seem agitated or confused? Patients who can only say a few words at a time, or are unable to complete their sentences without taking a breath, are in severe respiratory distress. No response clearly indicates a significant problem.

Try & listen to the chest to assess breath sounds and added noises. Listen for wheezes and lung consolidation, absent and reduced sounds may indicate a pleural effusion or a pneumothorax. A silent chest is a pre-terminal sign.

FEEL: Check the chest expansion to ensure equal and adequate movement on both sides. Palpate the chest wall to assess for surgical emphysema. Assess whether the trachea is central – any deviation may indicate tension pneumothorax or collapse/consolidation. Hyper-resonance on percussion may indicate a tension pneumothorax; dullness may indicate pleural effusion, haemothorax or consolidation.

C: Circulation 1.4.3.3

We are attempting to establish whether there is an adequate cardiac output and there is an adequate blood volume to provide tissue perfusion.

Initially the pulse should be checked and capillary refill time observed. Blood pressure can be estimated

THE PULSE

The pulse is a series of pressure waves within an artery caused by contractions of the left ventricle of the heart. It can be felt where an artery is near the surface of the body. In a healthy person the resting heart rate is 60-80 beats per minute.

The Radial Pulse

The Carotid Pulse

The site most commonly used to palpate the pulse is the wrist (radial pulse). Other pulses recorded are:

- Carotid – to the front of the neck;
- Femoral – felt in the groin;
- Dorsalis pedis – found on the top part of the foot, between the big toe and the leg;

The pulse is recorded to obtain information on the heart rate, pattern of beats and strength of the pulse. It is not just the pulse rate that is recorded – its rhythm and strength are also measured. The rhythm should be regular in a healthy person. The pulse should be strong and easily palpated – if it is bounding or weak then this is an indication that there is a possible problem.

To record a pulse you will need a watch that has a second hand. Explain to the casualty what you are about to do. Place your first and second finger along the artery – apply light pressure until you feel the pulse.

- Count the pulse for a full minute in order to detect any arrhythmias (abnormal rhythms).

CAPILLARY REFILL TIME (C.R.T.)

Capillary Refill Time

Capillary Refill Time

Capillary refill is the rate at which blood refills empty capillaries and is a common measure of peripheral perfusion. It can be measured by pressing the soft pad of a finger or toe until it turns white, and taking note of the time needed for colour to return once pressure is released. Capillary refill can also be measured by pressing on the sternum for five seconds with a finger or thumb, this is useful in a casualty who is extremely cold.

Normal capillary refill time (CRT) is less than 2 seconds. If the refil time is elongated then it can be asserted that a person is suffering from a reduced tissue perfusion such as shock. A CRT of greatter than 5 seconds is considered severe.

BLOOD PRESSURE (B.P.)

Blood pressure is a measure of how hard blood is pressing against artery walls in a cardiac cycle. Blood pressure is recorded as two numbers: the top number is called systolic pressure and is caused by the heart contracting, and the bottom number is called diastolic pressure which is the pressure of blood in the vessels while the heart is relaxing. A normal blood pressure is often $^{120}/_{80}$ mmHg (measured in mm of mercury). A low blood pressure is very often associated with shock.

If it is possible the blood pressure should be measured, as first aiders it is beyond our scope to perform an actual blood pressure recording, however a rough guide is the presence of a pulse in various locations.

- **Carotid pulse indicates a systolic pressure of around 60 mm Hg**
- **A femoral pulse a systolic pressure of around 70 mm Hg and**
- **A radial pulse a systolic pressure of around 90 mm Hg.**

The circulation survey should be conducted in a rapid systematic fashion using the look & feel approach.

LOOK: Check the skin colour. Does the patient look cyanosed and/or pale? Is there any sweating? In cases of sepsis (severe infection), patients may appear to be red/flushed and feel warm. Peripheral cyanosis (blue fingers / feet) may indicate reduced cardiac output.. Look for any obvious signs of haemorrhage.

Estimate Blood Pressure

FEEL: Check and compare peripheral and central pulses for presence, volume, character and regularity. Weak and thready pulses may indicate shock, whereas bounding high volume pulses may indicate severe infection. Estimate blood pressure. Check the capillary refill time.

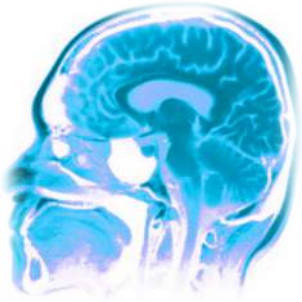
Feel the peripheral limb temperature and compare this to central temperature. Warm, well-perfused peripheries may indicate sepsis, whereas peripheral cooling and shut down may be present in shock, and will worsen as shock progresses.

D: Disability (Central Nervous System) 1.4.3.4

The objective here is to provide a rapid base-line of the neurological status of the casualty. In the initial primary survey, it is perhaps best done using the AVPU system. This stands for:

- **A** = **A**lert.
- **V** = Responds to **v**erbal stimulus.
- **P** = Responds to **p**ainful stimulus.
- **U** = **U**nresponsive.

Disability (C.N.S.)



A severely reduced level of consciousness is life threatening. When the patient is only responding to pain, or is unresponsive, care must be taken to protect and maintain the airway, as the normal protective airway reflexes may be absent/inadequate. Remember that reduced level of consciousness is the commonest cause of airway obstruction in the seriously ill. Consider whether you need to call for urgent medical help.

Check the pupil size and reaction to light. This may be helpful in determining chemical or physical brain injury.

Pupil Response

- Have the patient look at a distant object
- Look at size, shape and symmetry of pupils.
- Shine a light into each eye and observe constriction of pupil.
- Flash a light on one pupil and watch it contract briskly.
- Flash the light again and watch the opposite pupil constrict (consensual reflex).
- Repeat this procedure on the opposite eye.

Normal:

- Pupil size is 3-5 mm in diameter.
- They react briskly to light.
- Both pupils constrict consensually

Abnormal :

Causes of unequal pupil sizes may include:

- Bleeding inside the skull caused by head injury
- Brain tumor or abscess
- Infection of membranes around the brain caused by meningitis or encephalitis
- Aneurysm
- Excess pressure in one eye caused by glaucoma

Abnormal pupil include:

- Dilated pupils (enlarged)
- Pinpoint pupils (very small)
- Nonreactive pupils (pupils do not change size when exposed to light)

Causes of Abnormal pupil:

- Effects of Drugs or chemical agents.

E: Exposure / Environment 1.4.3.5

This is E for exposure. A limited quick top to toe survey can help to identify life threatening fractures and bleeding points. Verify possible existence of broken bones or any other injuries from head to toe leaving the details of minor fractures,

lumps, and bruises for the emergency department. If a critical emergency has been identified during the primary survey there may not be time to do this part.

A balance has to be taken between causing more problems, exacerbating hypothermia and the possibility of missing a pointer to a life-threatening problem. It is important to check to see that clothing, boots or the surface the patient is on' is not absorbing or masking any signs of severe external bleeding, however removing a casualties clothing in a pre-hospital situation is fraught with difficulty & a casualties dignity should be maintained **at all times**.

Casualty Examination

The main elements of a patient examination are the discovery of :

- A lack of symmetry
- Blood loss /Excessive fluid loss
- Distension
- Deformities
- Rashes
- Calf swelling
- Medic alert bracelets.

As always, a systematic approach to a casualty examination is the correct approach, with practice this process can be performed rapidly, the approach should include:

Bleeding

- Do a quick head to toe check for bleeding.
- Check the hidden area such as under the arch of the back.
- Control any major bleeding that you find.

Head and Neck

- Check the whole head, neck and face.
- Is it an accident that might have injured the spine? .

Shoulders and Chest

- Place your hands on opposite shoulders and compare them.
- Run your fingers down the collar-bones checking for signs of a fracture.
- Gently squeeze and rock the ribs.

Abdomen and Pelvis

- Push the abdomen with the palm of your hand to check for abnormality or response to pain.
- Gently check the pelvis for signs of a fracture.
- Look for incontinence or bleeding.

Legs and Arms

- Feel each leg for the signs of a fracture.
- Feel each arm for the signs of a fracture.
- Look for other clues (medic alert bracelets, needle marks etc).
- Look for clues and make sure nothing will injure the patient as you roll them into the recovery position.
- Have a witness if you remove items from pockets.
- Be very careful if you suspect there could be sharp objects such as needles.
- Loosen any tight clothing.

Remember:

- Never delay a casualties transit to hospital in a pre-hospital situation for a secondary assessment.
- Always maintain the patient's dignity and ensure that the patient is kept warm.

Casualty Triage 1.5

Triage, derived from the old French verb *trier* (meaning to sieve or sort), is the process by which both treatment and transport priorities are allocated to casualties.

Aim

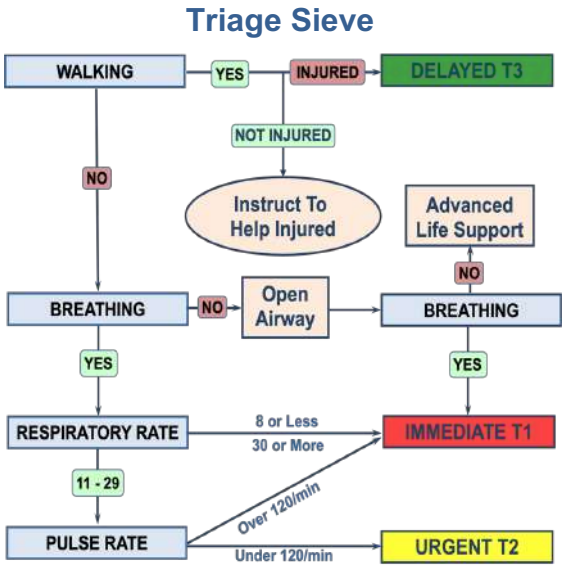
The aim of triage is to get the right patient the right care in the right place at the right time.
Treatment protocols concentrate on what to do with individual patients. Identifying the "sickest" patients and prioritising their treatment and evacuation is essential to reduce mortality and morbidity. In times of high casualty flow the principle of "doing the most for the most" is paramount. Triage enables this.
Triage is a military innovation and was first applied by Baron Dominic Jean Larrey, Chief Surgeon to Napoleon. The concept has been adopted widely in civilian settings for major incident and disaster medical management.

Triage Priorities

- **T1 Priority** **-IMMEDIATE-**
  These are casualties with life, limb or sight-threatening injuries (for example any of the A.T.O.M.F.C. conditions). Treatment is essential within an hour.
- **T2 Priority** **-URGENT-**
  These are casualties with serious injuries that require treatment within 2 hours (for example, fractured shaft of femur however, this could be categorised as T1 if the fracture was open and the haemorrhage was substantial).
- **T3 Priority** **-DELAYED-**
  These are casualties whose injuries can safely wait for up to 4 hours before treatment (for example, minor wounds, burns or fractures).
- **T4 priority** **-EXPEXTANT-**
  This priority should **NOT** be awarded routinely. T4 is reserved for those patients whose injuries are so severe that despite treatment the prognosis is hopeless (e.g. > 90% burns; open head injury with unresponsiveness). Using resources to treat these patients at times of high demand would jeopardise the potential survival of other salvageable casualties.
- **Dead** **-DEAD-**
  It is important to recognise death and to label bodies as dead. This prevents repeated assessment of the dead.

Triage Sieve

The *Triage Sieve* is a part of the rapid 'first look' primary survey It is suitable for initial assessment at point of wounding, or when the casualty load is high at successive points in the evacuation chain. It is designed for the first aider, to provide safe triage.



Emergencies 1.5.1

The first step of treating a medical emergency is in the detection of this emergency. The immediate life threatening conditions which a medic may discover can be remembered with the mnemonic **ATOMFC** :

- **A**irway obstruction.
- **T**ension pneumothorax.
- **O**pen pneumothorax.
- **M**assive haemothorax.
- **F**lail chest.
- **C**ardiac tamponade.

All of the appropriate interventions for these are discussed in the Clinical Skills Section. All of these conditions are detectable in the A.B.C.D.E. survey (which highlights its importance).

Cardio-Respiratory Arrest 2

A cardiac arrest is different from (but may be caused by) a heart attack. Cardiac arrest, is the cessation of normal circulation of the blood due to failure of the heart to contract effectively, and if this is unexpected can be termed a sudden cardiac arrest or SCA.

Sudden cardiac arrest is a leading cause of death in Europe, affecting about 700,000 individuals a year, in the majority of out of hospital cases the victim is initially in a heart rhythm called ventricular fibrillation (V.F.).

The immediate effect of a cardiac arrest is that the absence of blood circulation prevents delivery of oxygen to the body. Lack of oxygen to the brain causes loss of consciousness, which then results in abnormal or absent breathing. Brain injury is likely if cardiac arrest goes untreated for more than five minutes. For the best chance of survival and neurological recovery immediate treatment is essential.

The Chain Of Survival 2.1

Basic life support (BLS) or **Cardio-Pulmonary Resuscitation** (CPR) is a level of medical care that can be provided by laypersons who have received BLS training. BLS is generally used in the pre-hospital setting, and can be provided without medical equipment.

It is important to realize that CPR alone is **highly unlikely** to actually revive a person who has suffered a cardiac arrest.

Its fundamental use is to ensure that the main organs (particularly the brain) are perfused with oxygen in the time it takes medical help to arrive. As discussed, the majority of Sudden Cardiac Arrests are in a ventricular fibrillation rhythm. V.F. is classed as a 'shockable' rhythm and can be converted back to a 'normal' rhythm if the casualty has access to a defibrillator as soon as possible after a cardiac arrest. V.F. will eventually change into a heart rhythm called asytole over a period of minutes. Asytole is classed as a 'non-shockable' rhythm and a defibrillator is of no help. It is estimated that the chance of successful resuscitation reduces by 7-10% each minute a person is resuscitated without defibrillation.

It is for this reason that the availability of the public automated external defibrillator or AED, which can be used for defibrillation have become so common within the UK. There early use can increase the chance of survival from 5% to more than 50%.

It is for this reason that when training in B.L.S. it is paramount that the emphasis be placed on **Seeking Help Early.**

Basic Life Support 2.2

What follow is a detailed description of a rescuer's actions upon finding a casualty who has suffered from a cardiac arrest. It is the United Kingdom's Resuscitation Councils (UKRC) actual guideline with the associated Basic Life Support Algorithm.

All elements of this process comply with The S.A.F.E. approach ➔ Quick Look Primary Survey assessment.

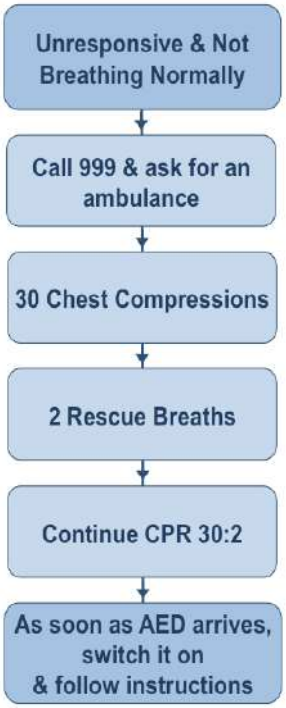
Adult 2015 UKRC BLS sequence is as follows:

SEQUENCE	TECHNICAL DESCRIPTION
SAFETY	Make sure you, the victim and any bystanders are safe
RESPONSE	**Check the victim for a response** • Gently shake his shoulders and ask loudly: "Are you all right?" If he responds leave him in the position in which you find him, provided there is no further danger; try to find out what is wrong with him and get help if needed; reassess him regularly
AIRWAY	**Open the airway** • Turn the victim onto his back Place your hand on his forehead and gently tilt his head back; with your fingertips under the point of the victim's chin, lift the chin to open the airway

BREATHING	**Look, listen and feel for normal breathing for no more than 10 seconds** In the first few minutes after cardiac arrest, a victim may be barely breathing, or taking infrequent, slow and noisy gasps. Do not confuse this with normal breathing. If you have any doubt whether breathing is normal, act as if it is they are not breathing normally and prepare to start CPR
DIAL 999	**Call an ambulance (999) (Or Emergency Medic Response)** Ask a helper to call if possible otherwise call them yourself. Stay with the victim when making the call if possible.
SEND FOR AED	**Send someone to get an AED if available** If you are on your own, do not leave the victim, start CPR
CIRCULATION	**Start chest compressions** Kneel by the side of the victim. Place the heel of one hand in the centre of the victim's chest; (the lower half of the sternum). Place the heel of your other hand on top of the first hand. Interlock the fingers of your hands and ensure that pressure is not applied over the victim's ribs. Keep your arms straight. Do not apply any pressure over the abdomen or the bottom end of the bony sternum. Position your shoulders vertically above the victim's chest and press down on the sternum to a depth of 5–6 cm. After each compression, release all the pressure on the chest without losing contact between your hands and the sternum; Repeat at a rate of 100–120 min.
GIVE RESCUE BREATHS	**After 30 compressions open the airway again using head tilt and chin lift and give 2 rescue breaths** • Pinch the soft part of the nose closed, using the index finger and thumb of your hand on the forehead. • Allow the mouth to open, but maintain chin lift. • Take a normal breath and place your lips around his mouth, making sure that you have a good seal. • Blow steadily into the mouth while watching for the chest to rise, taking about 1 second as in normal breathing; this is an effective rescue breath. • Maintaining head tilt and chin lift, take your mouth away from the victim and watch for the chest to fall as air comes out. • Take another normal breath and blow into the victim's mouth once more to achieve a total of two effective rescue breaths. Do not interrupt compressions by more than 10 seconds to deliver two breaths. Then return your hands without delay to the correct position on the sternum and give a further 30 chest compressions. • Continue with chest compressions and rescue breaths in a ratio of 30:2 **If you are untrained or unable to do rescue breaths, give chest compression only CPR (i.e. continuous compressions at a rate of at least 100–120 min)**
IF AN AED ARRIVES	**Switch on the AED** Attach the electrode pads on the victim's bare chest. If more than one rescuer is present, CPR should be continued while electrode pads are being attached to the chest. Follow the spoken/visual directions. Ensure that nobody is touching the victim while the AED is analysing the rhythm. **If a shock is indicated, deliver shock** • Ensure that nobody is touching the victim. • Push shock button as directed (fully automatic AEDs will deliver the shock automatically). • Immediately restart CPR at a ratio of 30:2. • Continue as directed by the voice/visual prompts. **If no shock is indicated, continue CPR** • Immediately resume CPR. • Continue as directed by the voice/visual prompts.
CONTINUE CPR	**Do not interrupt resuscitation until:** A health professional tells you to stop. You become exhausted. The victim is definitely waking up, moving, opening eyes and breathing normally. **It is rare for CPR alone to restart the heart. Unless you are certain the person has recovered continue CPR**

NOTE: In the first few minutes after cardiac arrest, a casualty may be barely breathing, or taking infrequent, noisy gasps. Do not confuse this with normal breathing. If you have any doubt, act as if it is not normal.

U.K. Resuscitation Council 2015 Basic Life Support Algorithm



Continue Resuscitation Until:

- Qualified help arrives and takes over.
- The victim starts breathing normally.
- You become exhausted.

Defibrillation 2.3

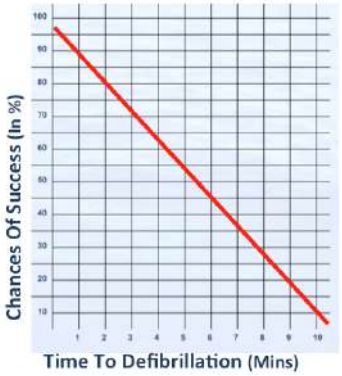
In the UK approximately 30,000 people sustain cardiac arrest outside hospital and are treated by emergency medical services each year.

Defibrillation is well established as the only effective therapy for cardiac arrest caused by ventricular fibrillation (V.F.) or pulseless ventricular tachycardia (V.T.). The scientific evidence to support early defibrillation is overwhelming; the delay from collapse to delivery of the first shock is the single most important determinant of survival.

If defibrillation is delivered promptly, survival rates as high as 75% have been reported. The chances of successful defibrillation decline at a rate of about 10% with each minute of delay; basic life support will help to maintain a shockable rhythm but is **not** a definitive treatment.

The Resuscitation Council (UK) recommends a policy of defibrillation with the minimum of delay in victims of V.F. / V.T. cardiac arrest.

The chance of successful resuscitation reduces by 7-10% each minute a person is resuscitated without defibrillation.



What Is An Automated External Defibrillator ?

An automated external defibrillator or AED is a portable electronic device that automatically diagnoses the potentially life threatening cardiac arrhythmias of ventricular fibrillation and ventricular tachycardia in a patient, and is able to treat them through defibrillation; the application of electrical therapy which stops the arrhythmia, allowing the heart to re-establish an effective rhythm.

Types Of AED's

AEDs are sophisticated, reliable, safe, computerised devices that deliver electric shocks to victims of cardiac arrest when the ECG rhythm is one that is likely to respond to a shock. Simplicity of operation is a key feature: controls are kept to a minimum, voice and visual prompts guide rescuers. Modern AEDs are suitable for use by both lay rescuers and healthcare professionals.

All AEDs analyse the victim's ECG rhythm and determine the need for a shock.

In the diving community AED's that are hyperbarically rated are being introduced. The depth rating of these devices are constantly being increased. Some companies modify the AED units to be operated externally and having the defib pads connect through a hull penetrator.

Hyperbaric A.E.D.

Operating An AED 2.3.1

General Things To Remember Before Using An AED:

- All AED's use a 1-2-3 operating system.
- Try to relax and stay calm.
- The AED automatically provides voice and text prompts to guide you through each step of its use.
- The defibrillator pads must have good contact with the patient's skin. The pads have a layer of sticky, conductive gel beneath the protective backing.
- It may be necessary to dry the patient's skin or to clip or shave excessive chest hair to provide good contact between the defibrillator pads and the patient's skin.

How To Use An AED

The Operation Of An AED Relies On A 3-Step Process:

- Step 1: Switch on the AED.
- Step 2: Attach pads & allow AED to detect cardiac rhythm.
- Step 3: Follow AED verbal / visual instructions. Deliver shock if it is advised.

A.E.D. 1-2-3 Operating System

A.E.D. STEP 1

Step 1 1

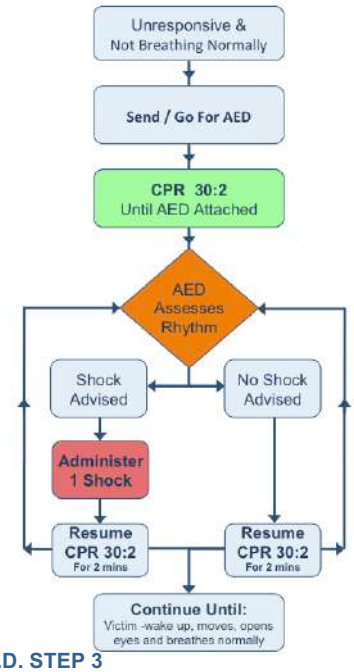
- Press the On/Off button to turn on the AED (this is always identified as **1**).

Step 2 (ECG analysis and CPR interval) 2

- Follow the instructions provided by the AED's voice and text prompts.
- Remove clothing from the patient's upper body. If needed, wipe moisture from the patient's skin and clip or shave excessive chest hair.
- Open the defibrillator pads package. Pull off the protective backing from pads.
- Place the sticky side of each pad on the patient's bare skin, exactly as shown on the drawing on each pad.
- Follow the instructions provided by the AED's voice and text prompts.
- As soon as the AED detects that the defibrillator pads are connected, it automatically begins analyzing the patient's heart rhythm.
- **Do not** touch the patient during rhythm analysis.
- If '**no shock'** is advised, the AED provides voice and text prompts to tell you to continue CPR for 2 minutes.
- After 2 minutes the AED provides voice and text prompts to tell you to discontinue CPR while it reanalyzes the ECG rhythm.

A.E.D. STEP 2

U.K. Resuscitation Council
A.E.D. Algorithm



Step 3 (Shock delivery) 3

- Do Not touch the casualty while the AED is charging, it continues to analyze the patient's heart rhythm. If the rhythm changes and a shock is no longer appropriate, the AED disarms. Voice and text prompts advise you what action to take.
- There are four ways you can tell that an AED is ready to deliver a shock:
  - You hear a voice prompt telling you to deliver a **Shock**.
  - You see the **Shock** button flashing.
  - You hear a steady tone.
  - You see a text prompt telling you to press the (**Shock**) button. (Which is always marked with a **3**).
- Observe the vicinity & ensure nobody is touching the casualty or that they are not touching anything conductive.
- Remove O_2 from the casualty.
- Give loud verbal instructions:
  - *'Oxygen away'*
  - *'Everybody clear. Preparing to shock'*
  - *'SHOCKING!'*
- Press the **Shock** button to deliver the shock. (Numbered **3**)
- After you press the Shock button, a voice prompt confirms that the shock was delivered.
- The AED provides voice and text prompts to tell you to continue CPR for 2 minutes. Discontinue this only if the casualty shows signs of life.

A.E.D. STEP 3

Shock button flashes.

NOTE: If you do not press the Shock button within 30 seconds of being prompted, the AED will automatically disarm itself and provide a pause. It will resume analyzing heart rhythm after 30 seconds.

Manual Airway Manoeuvres 2.4

Head Tilt- Chin Lift:

The rescuer places one hand on the patient's forehead and applies firm pressure backward with the palm to tip the patient's head maximally back.

The head tilt is usually augmented by using the other hand to support the patient's chin (head tilt - chin lift).

Head Tilt –Chin Lift

To Preform A Head Tilt – Chin Lift:

- Use one hand to press backward on the patient's forehead (head tilt).
- Place the fingers of your other hand under the bony part of the chin and pull the chin forward (chin lift), so that the teeth are nearly brought together.
- Avoid closing the patient's mouth, (unless you are performing mouth to nose ventilation).
- If the patient has loose dentures, use the thumb to hold them in position.
- Keep your fingers on the bony part of the chin and not to compress the soft tissues under the chin (this may itself cause airway obstruction).

Triple Airway Manoeuvre

This manoeuvre is useful when using a pocket mask to provide artificial ventilation.

Triple Airway Manoeuvre

To Preform A Triple Airway Manoeuvre:

- Place your fingers behind the angles of the patient's jaw.

- Forcefully displace the mandible forward.
- Tilt the head backward.
- Retract the patient's lower lip with your thumbs.

Jaw Thrust

The Head Tilt-Chin Lift & Triple Airway Manoeuvers' involve some extension of the neck and therefore could be dangerous where there is a cervical spinal injury.

In these cases a modified technique, the jaw thrust, may be used.

Jaw Thrust

To Preform A Jaw Thrust Manoeuvre:

- Kneel above the head of the patient, knees apart to give you balance.
- Hold the head with your hands to keep their head and neck in line with the body.
- Place your middle and index fingers under the jaw line of the patient (under their ears).
- Lift the jaw upwards with your fingers (This lifts the tongue from the back of the pharynx).

Recovery Position 2.5

An unconscious person cannot maintain his or her own airway. Many fatalities occur where the original injury or illness which caused unconsciousness is not inherently fatal, but where the unconscious person suffocates for one of these reasons.

When an unconscious person is lying face upwards, there are two main risk factors which can lead to suffocation: Fluids, possibly blood but particularly vomit, can collect in the back of the throat, causing the person to drown. When a person is lying face up, the oesophagus tilts down slightly from the stomach toward the throat. This, combined with loss of muscular control, can lead to the stomach contents flowing into the throat, called *passive regurgitation*. Fluid which collects in the back of the throat can also flow down into the lungs; stomach acid can attack the inner lining of the lungs and cause aspiration pneumonia.

It is possible to achieve limited protection of the airway by repositioning the casualty.

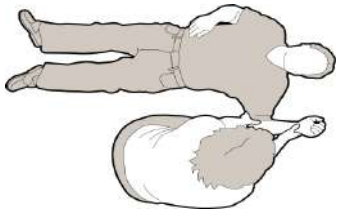
Recovery position

There are several variations of the recovery position, each with its own advantages. No single position is perfect for all victims. The position should be stable, near a true lateral position with the head dependent, and with no pressure on the chest to impair breathing.

The Resuscitation Council (UK) recommends to place a victim in the recovery position:

STEP 1

Remove the casualty's glasses and straighten both legs.
Move the arm nearest you outwards, elbow bent with palm uppermost.



STEP 2

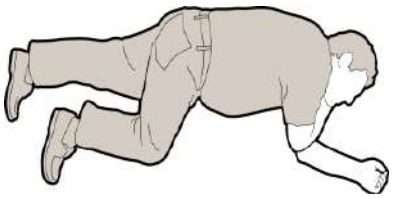
Bring the far arm across the chest,
and hold the back of that hand against the cheek.

STEP 3

With your other hand, grasp the far leg just above the knee, and pull it up, keeping the foot on the ground.
Keeping the casualty's hand pressed against their cheek, pull on the leg to roll them towards you, onto their side.

STEP 4

Adjust the upper leg so that the hip and knee are bent at right angles and tilt the head back to keep the airway open.



AIRWAY / BREATHING DISORDERS 3

Choking 3.1 (A.T.O.M.F.C.)

Early recognition of choking (airway obstruction by a foreign body) is the key to successful outcome, it is important not to confuse this emergency with fainting, heart attack, seizure, or other conditions that may cause sudden respiratory distress or loss of consciousness.

Foreign bodies may cause either mild or severe airway obstruction. The signs and symptoms enabling differentiation between mild and severe airway obstruction are summarized in the table below. It is important to ask the conscious victim 'Are you choking?'

Partial Airway Obstruction

Partial Airway Obstruction

Presentation of Choking:

General signs

- Attack occurs while eating
- Victim may clutch his neck

Signs of mild airway obstruction

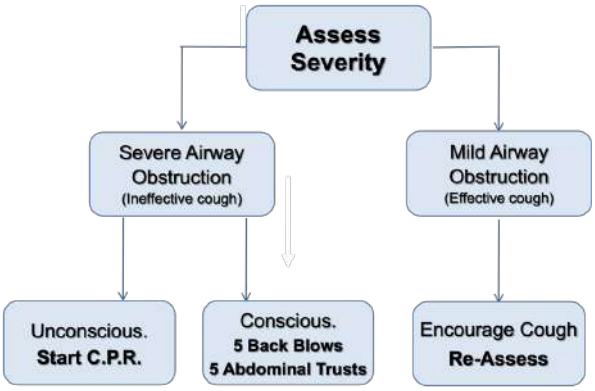
- Victim speaks and answers yes
- Victim is able to speak, cough, and breathe

Signs of severe airway obstruction

Response to question 'Are you choking?'

- Victim unable to speak
- Victim may respond by nodding
- Victim unable to breathe
- Breathing sounds wheezy
- Attempts at coughing are silent
- Victim may be unconscious

U.K.R.C. Choking Algorithm



Management of Chocking

If the victim shows signs of mild airway obstruction:

- Encourage him to continue coughing, but do nothing else.

Shows signs of severe airway obstruction and is conscious:

- Give up to five back blows.
  - Shout for help, but don't leave the patient yet.
  - Bend the casualty forwards so the head is lower than the chest.
  - Give up to 5 firm blows between the shoulder blades with the palm of your hand. Check between blows and stop if you clear the obstruction.

If the obstruction is still not cleared:

- Give up to 5 Abdominal thrusts
  - Stand behind the casualty. Place both your arms around their waist.
  - Make a fist with one hand and place it just above the belly button (below the ribs) with your thumb inwards.
  - Grasp this fist with your other hand, then pull sharply inwards and upwards. Do this up to 5 times. Check between thrusts and stop if you clear the obstruction.
  - If the obstruction is still not cleared:
  - Repeat steps 1 and 2
  - Keep repeating steps 1 and 2.
  - If the treatment seems ineffective, shout for help. Ask someone to dial 999 for an ambulance, but don't interrupt the treatment whilst the patient is still conscious.

Signs of severe airway obstruction and is unconscious:

- Support the casualty carefully to the ground.
- Start B.L.S.
- Continue CPR until the victim starts breathing normally, or you become exhausted

Abdominal thrusts can cause serious internal injuries, so send the patient to see a doctor.
After successful treatment, patients with a persistent cough, difficulty swallowing or with the feeling of an 'object still stuck in the throat' should also see a doctor.

Compromised Airway / Breathing 3.2 (A.T.O.M.F.C.)

Death from a compromised airway is the most common cause of death in the acutely ill casualty, regardless of whether the cause is originally airway in origin.

The casualty who has severe shock will develop reduced cerebral perfusion, which will cause a reduction in conscious level (due to hypoxia), which will lead to loss of the normal protective reflexes (gag & cough) and eventually lead to respiratory arrest. Therefore the level of consciousness is intrinsically linked to airway loss & death.

The fully conscious, talking patient is able to maintain his own airway. However a patient's status may deteriorate at any time and they must constantly be reassessed.

Presentation of a Compromised Airway / Breathing

- Choking presentation.
- Airway Secretions (saliva, blood, vomit, odaema).
- Abnormal airway sounds: snoring / stridor / wheeze.
- Neck signs (T.W.E.L.V.E) : Deviated trachea / wounds / emphysema / disrupted larynx / engorged neck veins.
- Breathing (RISE – FALL): Abnormal rate / visible injuries (front & back) / asymmetrical movement / accessory muscle use / chest wall emphysema / hyper-hypo resonant / abnormal breath sounds: crackles–silence.
- Low SpO_2 on pulse-oximeter (if vessel issued one).
- Cyanosis.

Scaled Airway Interventions

Management of a Compromised Airway / Breathing

- Seek medical assistance.
- Conduct primary / secondary survey & record observations.
- Open airway manually & inspect.
  - Heat tilt / chin lift / Jaw thrust.Recovery position.
- Observe for & clear obstructions.
  - Suction of secretions / vomitus.
  - Treat for choking.
  - Manually clear obstructions with magills forceps.
- Insert simple airway ajunct as tolerated:
  - Oro-pharangeal airway / Naso-pharangeal airway.
- Use an advanced airway Manoeuvre as indicated.
- Give High Flow O_2.
  - Via Non-Rebreather mask if Resp Rate >9 or < 40 (BPM).
  - Sit casualty in an upright position to promote lung expansion.
- Ventilate casualty with a B.M.V. (Connected to high flow O_2)
  - If resp rate is ≤ 8 or ≥ 40 (BPM).
- Treat cause of airway / breathing compromise.
- Continue to reassess regularly….DO NOT leave a casualty with a compromised airway.
- Prepare to evacuate (as per vessels S.O.P's).

Scaled Breathing Interventions

Asthma 3.3 (A.T.O.M.F.C.)

Asthma is a condition caused by an immune reaction in the lungs, often in response to substances such as dust, traffic fumes, or pollen. Muscles surrounding the bronchioles go into spasm and constrict, making it very difficult for the patient to breathe.

Most asthma sufferers carry an inhaler, usually a blue inhaler for relieving an attack, which dilates the bronchioles to relieve the condition.

An asthma attack is a traumatic and potentially life-threatening experience for the casualty.

Presentation of Asthma:

- History of previous asthma attacks.
- Abnormal airway sounds: **wheeze.**
- Breathing (RISE – FALL): **Rapid rate** / no visible injuries (front & back) / symmetrical movement / **gross accessory muscle use** / no emphysema / **hypo-resonant** / abnormal breath sounds: **wheeze / absent.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Low SpO_2 on pulse-oximeter (if vessel issued one).
- Rapid pulse rate (tachycardia).
- Pale, clammy skin / Grey or blue lips and skin (cyanosis).
- Casualty will become exhausted in a severe attack.
- May become unconscious and stop breathing in a prolonged attack.

Inhaler Therapy

Management of Asthmatic Attack:

- Identify and remove the cause of the asthmatic attack.
- Alert medical services.
- Conduct primary / secondary survey & record observations.
- Help the casualty to sit upright, leaning on a table or chair if necessary.
- Help the casualty to use their prescribed inhaler. (This can be repeated every few minutes if the attack does not ease).
- Implement compromised airway / breathing management (O^2 Therapy).
- Be calm & reassuring.
- If the attack is prolonged or worsening send for medic & resuscitation equipment.
- Implement shock treatment if condition worsening.
- Keep the casualty upright - even if they become too weak to sit up on their own.
  - Only lay an asthma attack patient down if they become unconscious.
- Be prepared to carry out resuscitation.

Volumatic

Hyperventilation 3.4

'Hyperventilation' means 'excessive breathing'. Hyperventilating reduces the carbon dioxide level in the blood, which can produce a dangerous alkalosis.

Hyperventilation often result from gross anxiety or 'panic attack'. Hyperventilation is often mistaken for asthma. The difference in the two conditions is the large volumes of air that can be heard entering the lungs of the hyperventilating patient, compared with the tight wheeze of the asthmatic.

Presentation of Hyperventilation

- Attention seeking behaviour. Feeling of a 'tight' chest / inability to breathe.
- Breathing (RISE – FALL): **Rapid rate** / no visible injuries (front & back) / symmetrical movement / **gross accessory muscle use** / no emphysema / normal resonance / normal breath sounds
- Flushed skin, no cyanosis.
- Pins and needles / cramps in hands & feet.
- **Normal** SpO_2 on pulse-oximeter (if vessel issued one).
- If the attack is prolonged, the casualty may pass out and stop breathing for up to 30 second.

"The contrasting difference between asthma & hyperventilation is the large volume of air that can be heard entering the lungs of the hyperventilating patient, compared to the tight wheeze of the asthmatic."

Management of Hyperventilation

- Conduct primary / secondary survey & record observations.
- Be firm and calm, but reassuring with the casualty.
- Explain to the casualty that they are hyperventilating.
- 'Coach' the casualty's breathing.
- Get them to breath SLOWLY & DEEPLY into a paper bag for no more than 5 minutes. (This normalizes the CO_2 levels)
- Call for medical advice if the attack is prolonged or you are in doubt.

Drowning 3.5 (A.T.O.M.F.C.)

There are two recognised types of drowning: Drowned and Near Drowned. A fluidic substance has asphyxiated a Drowned casualty and a Near Drowned casualty has been partially asphyxiated.

A casualty who drowns does not usually inhale large amounts of water into the lungs. 90% of deaths from drowning are caused by a relatively small amount of fluid entering the lungs, interfering with oxygen exchange in the alveoli. The other 10% are caused by muscle spasm near the epiglottis and larynx blocking the airway.

Drowned Victim

The casualty will usually ingest large amounts of water, which might then be vomited as they are rescued or resuscitation takes place.

Other factors may contribute to the cause of drowning, such as: hypothermia, an underlying medical condition such as epilepsy or heart attack.

Historically the term 'secondary drowning' has been used to describe a delayed respiratory reaction in the near-drowned victim. This is actually attributed to Acute Respiratory Distress Syndrome.

Drowning and Diving

The diving reflex is a primitive reflex, (attributed to a "mammalian reflex" found in seals and lower mammals) which causes a sharp drop in the heart rate when the body is suddenly immersed in cold water. Peripheral blood vessels constrict, reducing blood flow to the body surface and extremities.

In addition to these oxygen conservation effects, the breath-holding period is extended by about 15%. This is probably due to a depression of the body's sensitivity to the CO_2 levels, which normally stimulate the breathing reflex.

The diver has a further advantage in that he is breathing a higher than usual PPO_2 and his tissues will be carrying more oxygen.

Temperature Of The Water:

Under normal conditions brain damage would occur within 3 to 5 minutes. In cold water drowning, however, the effects of cold and the diving reflex reduce the brain's oxygen requirements considerably.

The rapid development of hypothermia can serve a protective function, particularly regarding brain viability in patients with prolonged submersion. The survival of a child submerged for 66 minutes in a creek with a water temperature of 5° C is the longest documented submersion with good neurological outcome.'

Hypothermia, which is organ protective, also contributes to neurological recovery after prolonged submersion, probably by decreasing the metabolic needs of the brain. Coldwater submersion may induce severe cardiac dysrhythmias.

Duration Of Submersion:

The longer the duration of submersion, the less likely the patient is to survive. When rescue operations have been in progress for more than 30 minutes, victims retrieved from warm water in summer months or in warm southern waters usually are considered nonviable. Because cold-water submersion for up to 60 minutes has been associated with neurological recovery, most patients rescued from cold-water drowning should receive resuscitative life-support measures. Resuscitation is indicated unless there is physical evidence of death (e.g., putrefaction and rigor mortis).

Cleanliness Of The Water:

Contaminants in water have an irritant effect on the pulmonary system, leading to bronchospasm and an increased tendency toward poor gas exchange. They also can cause a secondary pulmonary infection with delayed severe respiratory compromise.

Presentation of Drowning

- Coughing.
- Panic / exhaustion.
- Abdominal swelling (It is common to gulp water, which will increase the chance of vomiting)
- Hypothermia / bluish skin.
- Spitting up water or fluid that is usually pink or frothy.
- Unconsciousness. (The majority of drowning victims are actually discovered 'lifeless' in the water).
- Absence of breathing.

Management of Drowning

- Avoid getting into the water. 'Reach or throw - don't GO'.
- Alert Medical personnel / supervisor.
- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management.
- Attempt to drain water if inhaled (Suction, inclined recovery position).
- Monitor for & treat any hypothermia.
- Continually assess casualty.
  - Be prepared to initiate ARDS treatment.
- Assess for & treat shock.
- Prepare to evacuate / treat in medical facility.

Avoid Getting Into Water

Acute Respiratory Distress Syndrome (ARDS) 3.6 (A.T.O.M.F.C.)

ARDS may be caused by direct or indirect lung injury.

It is characterised by acute pulmonary changes such as destruction of surfactant-producing alveolar cells, alveolar collapse and destruction, and destruction of pulmonary capillaries. The permeability of the capillaries increases with massive flooding of the alveoli and bronchi with fluid. The resulting pulmonary oedema creates areas of hypoventilation, shunting, and severe hypoxemia.

The massive fluid shift from the intravascular compartment to the lungs may produce hypovolemia.

Lung Damage Follows A Typical Pattern:

- Inflammation of the lung.
- Damage to the surfactant.
- Impaired gas exchange. (VQ Mismatch).
- Systemic release of inflammatory mediators.
- Further inflammation & reduced gas exchange (++VQ Mismatch).
- Pulmonary oedema.
- Hypoxia.
- Multiple Organ Failure (MOF).

Direct Lung Injury Causes of ARDS:

- Near drowning (when surfactant washed away, much worse in polluted water).
- Aspiration of vomit (highly acidic vomit can cause rapid inflammatory alveolar changes).
- Toxic gas inhalation (Any caustic gas, however Pulmonary Oxygen Toxicity is essentially ARDS).
- Pulmonary infection. (localised & systemic release of inflammatory mediators causing alveolar damage).

Indirect Lung Injury Causes of ARDS:

- Severe sepsis (A Systemic Inflammatory Response (SIR's) will inflame pulmonary circulation resulting in VQ mismatch & MOF).
- Major trauma (trauma initiate a massive SIR's response).
- Reperfusion injury (common in crush injuries / release of a tourniquet. SIR's response caused by release of necrotic tissue).

Presentation of ARDS:

- Insidious onset over 12-24 hrs.
- Abnormal airway sounds: **wheeze.**
- Neck Signs: **Distended neck veins.**
- Breathing (RISE – FALL): **Rapid rate** / no visible injuries (front & back) / symmetrical movement / **gross accessory muscle use** / no emphysema / **hypo-resonant** / abnormal breath sounds: **wheeze / global creps / absent.**
- Pink frothy sputum (pulmonary odeama).
- Low SpO_2 on pulse-oximeter.
- Rapid pulse rate (tachycardia).
- Non-palpable radial pulse (Reduced blood pressure).
- Reduced conscious level (cerebral hypoxia / toxemia).
- Pale, clammy skin / Grey or blue lips and skin (cyanosis).

Management of ARDS:

- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management.
  - Positive pressure ventilation with high PEEP is common.
- Assess for & treat shock.
- Continually assess casualty.
- Alert medical personnel / supervisor & prepare to evacuate (as per vessel SOP's).

Open Pneumothorax 3.7 (A.T.O.M.F.C.)

Two layers of membrane called the 'pleura' surround each lung. Between these two membranes is the 'pleural cavity', containing a thin layer of 'serous fluid', this allows the layers to move against each other as we breathe.

If the chest is injured, the inner layer of the pleura could become perforated and the alveolar of the lung damaged. Air may then be drawn from the lung into the pleural cavity (Pneumothorax), causing the lung to collapse.

Pneumothorax

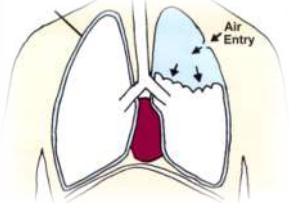
There Are Two Types Of Pneumothorax:

- Open Pneumothorax (the outer layer of the pleura is damaged, air can be sucked from outside of the chest into the pleural cavity).
- Closed Pneumothorax (The alveolar are ruptured & air escapes into the pleural layer, common in barotrauma or blast injuries). **See Diving Medicine Section For Management Of A Closed Pneumothorax.**

Open Pneumothorax

An open pneumothorax is a traumatic penetrating thoracic injury. If the hole in the chest is less than $^2/_3$ the size of the trachea air will selectively enter the chest through the normal means (airway-lungs), however if the hole is larger than this (above the size of a 50p piece) then air will be sucked into the pleural cavity. This is commonly referred to as a 'Sucking Chest Wound'

Sucking Chest Wound

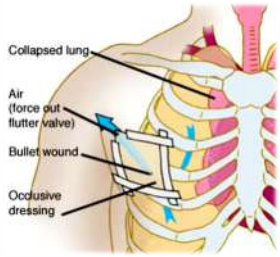


If air continues to be sucked into the pleural cavity, pressure in the collapsed lung can build *(tension pneumothorax).* This pressure build up can squeeze the heart, the major veins returning to the heart and the uninjured lung.

Presentation of an Open Pneumothorax

- Abnormal airway signs: **Distress / wheeze.**
- Neck Signs: **Trachea deviation** (late sign) / **possible Wounds** / **distended neck Veins / Emphysema present / L**arynx intact.
- Breathing (RISE – FALL): **rapid Rate** / **visible Injuries** (front & back) **bubbling & sucking** / **aSymmetrical movement** / **gross Effort & accessory muscle use** / **Feel emphysema / hyper-resonant on affected side** / breath sounds: **absent on affected side.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Painful breathing / complain of chest pain.
- Sound of air being drawn into the wound, with bubbling blood.
- Rapid pulse rate (tachycardia).
- Non-palpable radial pulse (Reduced blood pressure).
- Reduced conscious level (cerebral hypoxia).
- Pale, clammy skin / Grey or blue lips and skin (cyanosis).

Flutter Dressing



Management of an Open Pneumothorax

- Immediately cover a sucking chest wound with your hand *(or the casualty's hand if they are conscious)* to prevent air entry.
- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management.
- Alert Medical personnel & prepare to evacuate.
- Treat wound.
  - Use an improvised open pneumothorax flutter dressing (Gauze packaging with adhesive tape on 3 sides).
- Assess for tension pneumothorax & implement treatment if present.
- Treat Shock.
- Continually assess casualty.
- If casualty is in a hyperbaric environment be aware that a pneumothorax can evolve into a tension pneumothorax on ascent.

Improvised Flutter Dressing

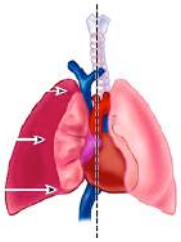
Tension Pneumothorax 3.8 (A.T.O.M.F.C.)

A tension pneumothorax is the progressive build-up of air within the pleural space, usually due to a lung laceration (due to an external penetrating injury or internal alveolar rupture), which allows air to escape into the pleural space but not to return.

Positive pressure ventilation may exacerbate this 'one-way-valve' effect. Progressive build-up of pressure in the pleural space pushes the mediastinum to the opposite hemi-thorax, and obstructs venous return to the heart. This leads to circulatory instability and may result in traumatic cardiac arrest.

A tension pneumothorax is possible after physical trauma to the chest, blast injury or as over expansion barotraumas whilst diving.

Tension Pneumothorax



Presentation of Tension Pneumothorax

- Abnormal airway signs: **Distress / wheeze.**
- Neck Signs: **Trachea deviation** (late sign) / **possible Wounds** / **distended neck Veins / Emphysema present / L**arynx intact.
- Breathing (RISE – FALL): **rapid Rate** / possible **visible Injuries** (front & back) / **aSymmetrical movement** / **gross Effort & accessory muscle use** / **Feel emphysema - hyper-resonant on affected side** / breath sounds: **absent on affected side.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Painful breathing / complain of chest pain.
- Low SpO_2 on pulse-oximeter.
- Rapid pulse rate (tachycardia).
- Non-palpable radial pulse (Reduced blood pressure).
- Reduced conscious level (cerebral hypoxia).
- Pale, clammy skin / Grey or blue lips and skin (cyanosis).

Needle Decompression

Management of Tension Pneumothorax

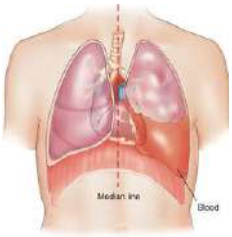
- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management.
- Alert Medical personnel & prepare to evacuate (as per company SOP's).
- Treat Shock.
- Casualty will require URGENT medical intervention.
  - A needle thoracocentesis on the affected side (inserted by qualified personnel).
  - Casualty will require a formal chest drain (inserted by qualified personnel).
- Continually assess casualty.
- Manage any wounds.

Massive Haemothorax 3.9 (A.T.O.M.F.C.)

A haemothorax is a condition that results from blood accumulating in the pleural cavity. This is usually due to a penetrating wound disrupting the systemic or pulmonary vessels.

Each hemi-thorax can hold up to 2·5 litres of blood, well enough to induce category IV shock & probably fatal.

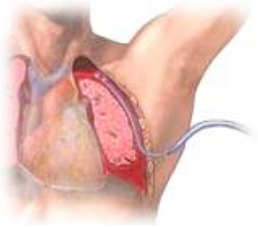
Left Haemothorax



Presentation Of A Massive Haemothorax

- Abnormal airway signs: **Distress / wheeze.**
- Neck Signs: Trachea central / **possible Wounds** / **distended neck Veins /** no **E**mphysema **/ L**arynx intact.
- Breathing (RISE – FALL): **rapid Rate** / possible **visible Injuries** (front & back) / **aSymmetrical movement** / **gross Effort & accessory muscle use** / **Feel hypo-resonant on affected side** / breath sounds: **absent on affected side.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Painful breathing / complain of chest pain.
- Low SpO_2 on pulse-oximeter.
- Rapid pulse rate (tachycardia).
- Non-palpable radial pulse (Reduced blood pressure).
- Reduced conscious level (cerebral hypoxia).
- Pale, clammy skin / Grey or blue lips and skin (cyanosis).
- Hypovolaemic Shock.

Haemothorax Drainage



Management Of A Massive Haemothorax

- Conduct primary / secondary survey & record observations.
- Alert Medical personnel.
- Implement compromised airway / breathing management.
- Treat Shock.
- Implement haemorrhage management.
- Casualty will require a formal chest drain inserted by qualified personnel as a matter of URGENCY.
- Continually assess casualty.
- Prepare to evacuate (As per vessel SOP's).

Flail Chest 3.10 (A.T.O.M.F.C.)

This is a condition where the ribs surrounding the chest have become fractured in several places, creating a 'floating' section of the chest wall.

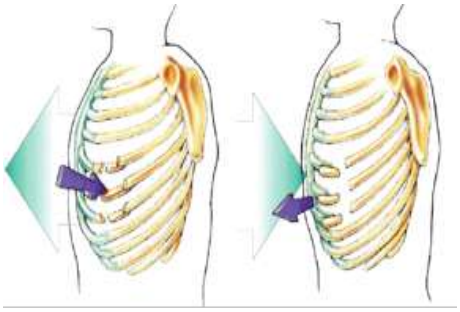
As the casualty breathes, the rest of the chest wall moves out, but the flail segment moves inwards. As the chest wall moves back in, the flail segment moves outwards.

These are called 'paradoxical' chest movements.

Presentation of Sucking Flail Chest

- Abnormal airway signs: **Distress.**
- Neck Signs: Trachea central / **possible Wounds** / **distended neck Veins / Possible Emphysema / L**arynx intact.
- Breathing (RISE – FALL): **rapid Rate** / possible **visible Injuries** (front & back) / **aSymmetrical PARADOXICAL movement on affected side** / **gross Effort & accessory muscle use** / **Feel hypo-resonant on affected side** / breath sounds: **creps on affected side.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Painful breathing / complain of chest pain.
- Low SpO_2 on pulse-oximeter.
- Rapid pulse rate (tachycardia).
- Non-palpable radial pulse (Reduced blood pressure).
- Reduced conscious level (cerebral hypoxia).
- Pale, clammy skin / Grey or blue lips and skin (cyanosis).
- Signs and symptoms of a fracture (see musculo-skeletal injuries).

Flail Chest



Management of Sucking Flail Chest

- Alert Medical personnel & prepare to evacuate.
- Conduct primary / secondary survey & record observations.
- Place the casualty in the position they find most comfortable - sat up, inclined towards the injury if possible.
- Place large amounts of padding over the flail area.
- Implement compromised airway / breathing management.
- Monitor for & treat a tension pnemothorax if present.
- Treat Shock.
- Place the arm on the injured side in an elevated sling. Squeeze the arm gently against the padding to provide gentle, firm support to the injury.

Flail Chest Management

CIRCULATION DISORDERS 4

Shock 4.1 (A.T.O.M.F.C.)

The medical term shock is defined as 'inadequate tissue perfusion, caused by a fall in blood pressure or blood volume.

'Inadequate tissue perfusion' means an inadequate supply of oxygenated blood to body tissue.
It is **always** serious and can quickly result in death if not treated.

Normal System

The Common Types Of 'Life Threatening' Shock Are:

- Hypovolaemic Shock.
- Cardiogenic Shock.
- Septic Shock.
- Neurogenic Shock.
- Anaphylactic Shock.

For Practical Purposes All Types Of Shock Can Be Split Into 3 Areas:

- The Heart.
- The Vascular System.
- The Circulating Fluid / Blood.

Generic Presentation of Shock:

Compensation phase (depending on the fitness of a casualty, they will increase their vascular tone & intravascular load through the production of adrenaline, nor-adrenaline, aldosterone)

- Tachypnea (fast respiratory rate).
- Sweating (Often Cold & Clammy).
- Tachycardia of 120-130 beats per minute.

De-compensation phase (The casualty had depleted there 'vascular reserves' & can no longer compensate)

- Fast, shallow breathing.
- Rapid, weak pulse.
  - Non–Palpable radial pulse.
  - Will lose femoral pulse in Cat IV Shock.
- Elongated CRT.
- Confusion, anxiety, even aggression.

End Phase (Cerebral hypoxia due to reduced perfusion):

- Deep, sighing breathing (air hunger).
- Unconsciousness. (With AIRWAY compromisation)

Shock Category	Category I Compensated	Category II Compensated	Category III De-compensated	Category IV De-compensated
Airway	Patent	Patent	Compromised	Collapsed
Breathing	Normal (12 B.P.M)	Raised (14-16 B.P.M.)	Rapid (> 20 B.P.M.)	Air Hunger (> 45 B.P.M.)
Circulation	Pulse Rate: Normal	Pulse Rate: Normal	Pulse Rate: Rapid	Pulse Rate: Undetectable
	Radial Pulse: Normal	Radial Pulse: Palpable	Radial Pulse: Absent	Radial Pulse: Absent
	C.R.T.: 2 seconds	C.R.T.: 2-4 seconds	C.R.T.: 5 seconds	C.R.T.: Absent
Disability Conscious Level	Alert	Alert	Voice / Pain	Pain / Unresponsive
Exposure Skin	Normal	Pale	Pale / Blue	Blue / Cold

Shock Classification:

The progression through the Compensated to end stage de-compensated shock is commonly classified from grade I to grade IV. It is a useful tool in the pre-hospital situation & a great predictor of eventual patient outcome.

Grade IV shock is often associated with imminent death.

Generic Management of Shock

- Alert Medical personnel & prepare to evacuate.
- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management.
- Identify & deal with injury or causes of shock.
- Lay the casualty flat with legs elevated (*Caution... For no more than 10 mins).**
- Continually assess casualty.
- Implement the management of the unconscious casualty.

Elevate Legs (For Short Periods)

*The biological response to shock is to increase peripheral resistance and cardiac output by increasing the contractility of the heart, heart rate, and arterial vasoconstriction, which results in an increased blood pressure. This response is called a 'baroreflex'.
Legs elevation increases the amount of vital circulating volume to the vital organs (by as much as 1.5 litres). However if a casualty's legs are elevated it can interfere with this normal 'baroreflex' response. Therefore it is essential that this is a short term measure.

Hypovolaemic Shock 4.1.1 Hypovolaemic (hypo=low + volaemic = volume) (A.T.O.M.F.C.)

This type of shock is caused by sudden loss of blood volume. Without the required volume of blood, the heart cannot pump enough blood to make up for the blood loss and organs begin to fail.

Water makes up 55% of blood. If the body becomes dehydrated because water is lost or fluid intake is inadequate, the body tries to maintain cardiac output by making the heartbeat faster. But as the fluid losses mount, the body's compensation mechanisms fail, and shock will occur.

Typical Causes Of Hypovolaemic Shock Are:

- External / external bleeding.
- Burns.
- Heat illness.
- Vomiting and diarrhoea (loss of body fluids).

Fluid / Blood Loss

Presentation of Hypovolaemic Shock:

- All elements of Generic Shock Symptoms.
  - Appearance: Cold, pale, clammy (cold sweat).
- Fluid loss (blood, sweating, vomit, diarrhea, burns).
- Acute Thirst.

Management of Hypovolaemic Shock

- Implement generic shock measures.
- Search for site of fluid loss & implement control measures.
  - Haemorrhage control.
  - Heat illness treatment.
  - Burns management.
  - D&V management.

Control Bleeding

Cardiogenic Shock 4.1.2 (A.T.O.M.F.C.)

Cardiogenic shock occurs when the heart becomes damaged, from a heart attack for example. In a weakened state the heart is unable to pump the blood effectively and supply to the body's tissues.

Typical Causes Of Cardiogenic Shock Are:

- Cardiac disease.
  - Myocardial infarction (heart attack).
  - Cardiomyopathy.
  - Arrhythmia.
  - Valve Disease.
- Trauma
  - Pericardial Tamponade.
  - Rupturing of the Heart.
- Pulmonary Embolism (including Arterial Gas Embolism).

Weak Heart

Presentation of Cardiogenic Shock:

- All elements of Generic Shock Symptoms.
  - Appearance: Cold, pale, clammy (cold sweat). Exceptionally cold limbs.
- Clinical signs of underlying cause (chest pain, palpitations, chest trauma).
- Distended jugular veins.
- Pulmonary oedema (involving fluid back-up in the lungs due to insufficient pumping of the heart).

Hyperbaric Therapy For A.G.E

Management of Cardiogenic Shock

- Implement generic shock measures.
- Search for and treat underlying cause (angina management, surgery, hyperbaric therapy).

Septic Shock (Septicaemia) 4.1.3 (A.T.O.M.F.C.)

Septic shock occurs when bacteria in the body multiply to unsafe levels and begin releasing toxins into the blood stream. This can result from bacterial infections like pneumonia and meningitis.

The immunological response to the bacterium causes dilation of the blood vessels & the hyperthermic reaction caused severe fluid depletion through perspiration and leakage of blood plasma from the intravascular system to the extra.

It can cause multiple organ failure. The mortality rate from septic shock is approximately 50%

Causes Of Septic Shock Are:

- Overwhelming bacteriamia (including meningitis, wound infections, bowel perforation & pneumonia).
- Hypovolaemic shock (reduced gut perfusions causes bowel bacteria to 'translocate' to the vascular system).
- Major Trauma (Also called 'cold sepsis', massive inflammatory mediator release in response to large injuries).
- Re-perfusion (if a tourniquet or crushed limb is released, an endotoxin load can be dumped into the circulation).

Vascular inflammation & Fluid Loss

Presentation of Septic Shock:

- All elements of Generic Shock Symptoms.
  - Appearance: Warm, flushed, clammy (hot sweat). Possible cold extremities.

- Rapid 'Bounding' pulse (due to vascular dilation).
- Signs of Infection (sputum, discharge, inflammation).
- High temperature > 37.6°C (The higher the temperature, the more serious > 38.5°C = serious).

Later Signs

- Fall in body temperature below the normal level of 36°C
- Loss of peripheral pulse.
- Skin becomes cool and mottled (blotchy).
- Severe Odeama (due to 3rd spacing of intravascular fluid, it 'shifts' to the extracellular space).
- Severe Confusion (due to cerebral hypoxia / toxemia).
- Reduced conscious level.

Antibiotics

Paracetamol / Ibuprofen

Management of Septic Shock:

- Implement generic shock measures.
- Search for and treat underlying cause (antibiotic therapy, surgical intervention).
- Give medication as instructed (anti-pyretical agents: paracetamol / ibuprofen. Antibiotics).
- Fever management / cooling.

Neurogenic Shock 4.1.4 (Spinal Shock) (A.T.O.M.F.C.)

Neurogenic shock (or Spinal Shock) can result from severe central nervous system damage (brain injury, cervical or high thoracic spinal cord).

The trauma causes a sudden loss of the sympathetic nervous stimulation to the blood vessels. This causes them to relax (vasodilation) resulting in a sudden decrease in blood pressure (secondary to a decrease in peripheral vascular resistance).

It commonly results in low blood pressure, heat loss and warm, dry skin. Hypothermia may also occur after neurogenic shock because the body loses its ability to adequately siphon blood from the extremities back to the core & a rapid peripheral cooling of the blood.

Typical Causes Of Neurogenic Shock Are:

- Direct spinal trauma.
- Indirect spinal trauma.
- Spinal space occupying lesion (tumour, gas embolism, infection).

Dilated System

Presentation of Neurogenic Shock:

- All elements of Generic Shock Symptoms.
  - Appearance: Warm, dry, flushed skin.
- Bounding pulse (Peripheral vasodilation).
- Venous pooling (blood collecting in the veins of the lower extremities).
- Poikilothermia (body temperature that varies with the temperature of its surrounding).
- Priapism (Permanent penile erection).

PASG Trauma Trousers

Management of Neurogenic Shock:

- Implement generic shock measures.
- Search for and treat underlying cause (immobilisation, hyperbaric therapy).
- Avoid removing tight constrictive clothing.
- Elevate legs (for 10-minute intervals. Avoid if spinal fracture suspected).
- Pneumatic anti-shock garments (PASG) or 'trauma trousers' have proved useful (by pushing 3rd spaced fluid back into the central circulation).

Anaphylactic Shock 4.1.5 (Allergic Reaction) (A.T.O.M.F.C.)

Anaphylaxis is an extremely dangerous allergic reaction. The name 'anaphylaxis' means 'without protection' and indeed, the condition is caused by a massive over-reaction of the body's protection (immune) system.

When the body detects a foreign element, the autoimmune system releases anti-inflammatory anti-histamines to suppress the invader. However in the casualty with anaphylaxis, both anti-histamine & histamine (in massive amounts) are released. Histamine is a powerful 'pro-inflammatory' mediator, which will commence a cascade of adverse reaction.

Dilated Vasculature Fluid Loss & Weakened Heart

Severe anaphylactic reactions are very rare and affect only a small percentage of the population. Essentially the body turns on itself. An anaphylactic casualty will actually initiate this response on the 'second' encounter with the foreign body (their immune system will identify the agent & create an antibody to initiate its response the 'next' time it encounters it).

Histamine Has Several Effects When It Is Released In Mass-Quantities:

- Gross inflammation makes blood capillary walls 'leaky' (Causing a fall in blood volume).

  - It makes blood vessels dilate (causing a fall in blood pressure).
- It constricts the bronchioles in the lungs (due to alveolar arteriole dilation).
- It weakens the strength of the heart's contractions (causing a fall in cardiac output).
- It makes the skin come out in a rash (due to the pro-inflammatory mediators in the circulation).

The Causes Of Anaphylaxis

Typical Causes Of Anaphylactic Shock Are:

- Reactions to drugs (such as penicillin).
- Stings / venom.
- Foods (peanuts / seafood / preservatives).
- Pollen.
- Latex.
- Animal fur.

Anaphylaxis Rash

Presentation of Anaphylactic Shock:

- All elements of Generic Shock Symptoms.
  - Appearance: Itchy skin with red, blotchy / hot hives over chest-neck. Clammy pale extremities.
- Airway Signs: swelling of tongue, lips & face.
- Abnormal airway sounds: inspiratory / expiratory **wheeze.**
- Neck Signs: **T**rachea central / no **W**ounds / **distended neck Veins /** no **E**mphysema **/** Larynx swollen.
- Breathing (RISE – FALL): **Rapid rate** / no visible injuries (front & back) / symmetrical movement / **gross accessory muscle use** / no emphysema / **hypo-resonant** / abnormal breath sounds: **wheeze / absent.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Low SpO_2 on pulse-oximeter.
- Bounding pulse (Peripheral vasodilation).
  - Radial pulse will quickly be lost (as venous pooling / 3rd spacing occurs).
- Reduced conscious level (due to cerebral hypoxia / toxemia).

Epi-Pen

Management of Anaphylactic Shock:

- Implement generic shock measures.
- Search for and remove underlying cause (food, drug, animal).
- Alert medical personnel / supervisor highlight the presence of anaphylaxis & its **urgency.**
- Implement compromised airway / breathing management (O^2 Therapy).
- Be calm & reassuring.
- If the attack is prolonged or worsening resuscitation equipment.
- Implement the UKRC treatment algorithm.
  - Give I.M. Adrenaline (1:1000 - 500 mcg's / 0.5ml Epi-Pen) **as instructed**.
  - **Repeat** if instructed.
- Continually monitor casualty & prepare to evacuate.

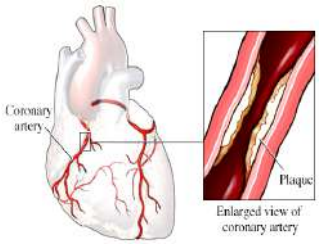
Coronary Artery Disease 4.2

(A.T.O.M.F.C.)

Angina (angina pectoris) caused by the build up of a cholesterol plaque on the lining of the coronary arteries. Cholesterol is a fatty chemical, which is part of the outer lining of cells in the body. A cholesterol plaque is a hard, thick substance caused by deposits of cholesterol on the artery wall. Over time, the build up of the plaque can cause narrowing and hardening of the artery.

During exercise, the heart requires more oxygen, but the narrowed coronary artery cannot increase the blood supply to meet this demand. As a result an area of the heart will suffer from a lack of oxygen. The patient will feel pain in the chest (amongst other symptoms) as a result.

Angina / Unstable Angina



Acute Coronary Syndrome Can Be Divided Into 3 Types:

Angina

Typically, an angina attack occurs with exertion, and subsides with rest.

Unstable Angina

If the narrowing of the artery reaches a critical level, angina at rest (called 'unstable angina') may result. There is a high risk of suffering a heart attack.

Myocardial Infarction (Heart Attack)

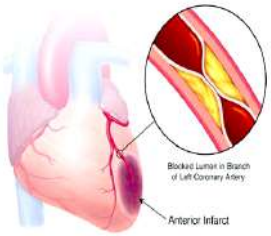
A heart attack (myocardial infarction) is often caused when the surface of a cholesterol plaque in a coronary artery cracks and has a 'rough surface'. This can lead to the formation of a blood clot on the plaque, which completely blocks the artery resulting in the death of an area of the heart muscle.

Unlike angina, the death of the heart muscle from heart attack is permanent and will not relieved by rest.

Trigger factors associated with Acute Coronary Syndrome:

- Previous medical history of heart disease.
- Smoking.
- Stress.
- Anaemia.
- Physical exercise.
- Extreme temperatures.
- Eating a heavy meal.

Myocardial Infarction

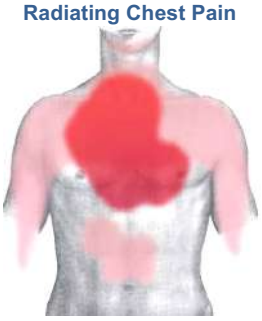


Presentation of Acute Coronary Syndrome (ACS):

It should be remembered that every heart attack is different. Only a few of the signs symptoms may be present, indeed up to a quarter of heart attacks suffered are silent without any chest pain.

- Chest pain (Normally central chest pain and can feel like tightness or squeezing).
- Referred Pain:
  - Usually the left arm is affected but it can affect both arms.
  - Jaw & neck.
  - Back.
  - Abdomen.
- Relation to exercise:
  - Angina: **relieved** on rest.
  - Unstable Angina: **Not** relieved on rest.
  - Myocardial Infarction: **Not** relieved on rest.
- Overwhelming anxiety (similar to having a panic attack).
- Wheezing / Shortness of Breath.
- Nausea / vomiting / indigestion.
- Cardiogenic shock.
  - Sweating or cold, sweaty skin.
  - Rapid or irregular heart beat.

Radiating Chest Pain



Management of Acute Coronary Syndrome

- Conduct primary / secondary survey & record observations.
- Cease strenuous activity & assess.
- Is the pain alleviated?
- Instigate emergency therapy if pain is **not** relieved:
  - Alert medical personnel / supervisor & prepare to evacuate (A.C.S. is SERIOUS and life threatening).
  - **O**xygen.
  - **N**itrates.
  - **A**spirin.
- Reassess A.B.C.D.E. Regularly.
- Instigate cardiogenic shock management as necessary.
- Evacuate (E.T.H.A.N.E. – M.I.S.T.).

A.C.S. Treatment

NOTE: Aspirin reduces the clotting ability of the blood. Chewing the tablet allows the drug to absorb quickly into the blood through the skin of the mouth, so it works faster.

Differential Chest Pain Diagnosis

Many conditions produce the symptom of chest pain. Therefore it is important for the medic to be suspicious and consider the alternate reasons that this symptom may present.

Gastric Ulcer

These Include:

- Cardiovascular
  - Acute Coronary Syndrome.
  - Altered Heart Rhythm.
  - Aortic aneurysm.
  - Pulmonary Embolism (Including Arterial Gas Embolism).
- Gastric
  - Ulcer
  - Hernia.
  - Gastritis.
- Respiratory.
  - Pneumothorax.
  - Pneumonia / lung disease.
- Anxiety (panic attack / hyperventilation).
- Drugs.

Lung Disease

Fainting 4.3 (Syncope)

Fainting or syncope is a temporary loss of consciousness generally caused by transient cerebral hypoxia due to a sudden drop in blood pressure.

Unlike a seizure, the person who faints usually regains alertness soon after regaining consciousness. Fainting can also be a symptom of a more serious, underlying condition.

There Are Several Variant Causes Of Syncope:

Vasovagal Syncope

Due to sudden stimulation of the vasovagal nerve, which may have profound cardiovascular effects.

It May Be Initiated By:

- Sudden exposure to an unpleasant sight or experience.
  - Sudden stress, emotional upset, fear or anxiety.
- Bodily function: coughing, defecating, laughing.

Vasovagal Syncope

Postural Hypotension

Failure to compensate blood pressure. May present if casualty suddenly stands up.

It May Be Initiated By:

- Low blood volume (Dehydration / Heat Illness / blood loss).
- Underlying Medical Condition (hypotension / cardiac failure).
- Medication (anti-hypertensive's / diuretics).

Presentation of Syncope:

- Blurred vision or dizziness.
- Temporary loss of consciousness, falling to the floor.
- Slow pulse.
- Pale, clammy skin.
- Quick recovery.

Fainting

Management of Fainting:

- Conduct primary / secondary survey & record observations.
- Be suspicious... Fainting may be a *symptom.*
  - Treat underlying cause.
- Implement Shock Management.
- Continually assess casualty & record observations.
- Reassure the casualty as they recover. Do not allow them to sit up suddenly.
- If the casualty does not recover quickly or you are unsure, seek medical support.

Haemorrhage 4.4 (Blood Loss) (A.T.O.M.F.C.)

Haemorrhage is a loss of blood from the blood vessels. Continued bleeding will lead to collapse and death. The first aider must aim to control severe bleeding.

The amount of blood in our body varies in relation to our size. A rough rule of thumb is that we have approximately 500mls to every 7kgs of body mass, so the average adult has 4.5 to 6.5 litres of blood.

Bleeding Wound

Types of bleeding

Arterial

Blood in the arteries is under direct pressure from the heart pumping and spurts in time with the heartbeat. A wound to a major artery could result in blood 'spurting' several metres and the blood volume will rapidly reduce. Blood in the arteries is rich in oxygen and is 'bright red'.

Blood Loss	Category I Shock 10% (500mls) Compensated	Category II Shock 20% (1000mls) Compensated	Category III Shock 30% (1500mls) Uncompensated	Category IV Shock 40% (2000mls) Uncompensated
Airway	Patent	Patent	Compromised	Collapsed
Breathing	Normal (12 B.P.M)	Raised (14-16 B.P.M.)	Rapid (> 20 B.P.M.)	Air Hunger (> 45 B.P.M.)
Circulation	Pulse Rate: Normal	Pulse Rate: Normal	Pulse Rate: Rapid	Pulse Rate: Undetectable
	Radial Pulse: Normal	Radial Pulse: Palpable	Radial Pulse: Absent	Radial Pulse: Absent
	C.R.T.: 2 seconds	C.R.T.: 2-4 seconds	C.R.T.: 5 seconds	C.R.T.: Absent
Disability Conscious Level	Alert	Alert	Voice / Pain	Pain / Unresponsive
Exposure Skin	Normal	Pale	Pale / Blue	Blue / Cold

Venous

Veins are not under direct pressure from the heart, but veins carry the same volume of blood as the arteries. A wound to a major vein may 'ooze' profusely.

Capillary

Bleeding from capillaries occurs in all wounds. Although the flow may appear fast at first, blood loss is usually slight and is easily controlled.

Effects Of Blood Loss

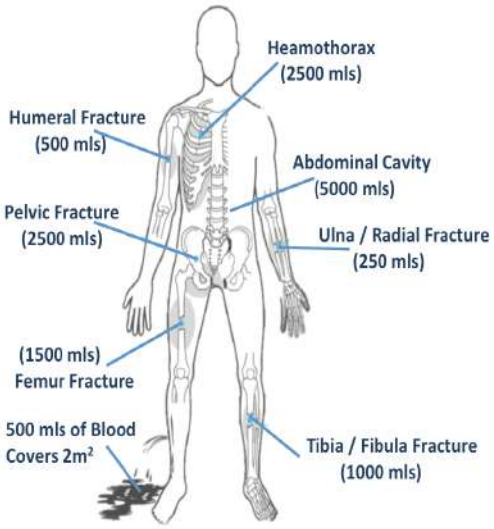
The body has a 'compensatory' response to severe blood loss, the vascular beds will constrict to utilize the reduced blood volume to supply vital organs. As blood loss increases the blood vessels cannot constrict any further and the heart cannot beat any faster, so blood pressure falls, resulting in unconsciousness (due to cerebral hypoxia) and then death (exsanguination).

The volume of blood lost is critical. The more blood lost then the greater the Hypovolaemic shock. For every 500mls (10% total blood volume) lost then the casualty will advance a stage in shock category.
A loss of 30% of blood volume is critical – the patient's condition rapidly deteriorates from this point onwards due to a loss of vascular compensation (De-compensation).

The table below shows the effects, signs and symptoms of blood loss.

Bleeding Sites

It is quite possible to haemorrhage huge volumes of blood and never spill a drop onto the floor. Large internal cavities such as the pelvis, abdomen & chest can store large amounts of blood & are difficult to control because direct pressure cannot be placed upon the actual bleeding vessel, this is termed non-compressible.
The long bones can also produce huge storage capacities for blood, the thigh may store up-to 1500mls of blood & the calf 1000mls. The result of this may result in a critical category IV shock with extensive trauma to one limb.
As a general rule a limb injury is a 'compressible haemorrhage' & a torso injury is a 'non-compressible haemorrhage'.



Presentation of Bleeding:

Compressible Bleeding

- Obvious signs of bleeding.
- Signs of hypovolaemic shock.

Non-Compressible Bleeding

- Signs of hypovolaemic shock.
- Bruising / swelling at site of injury.
- Pain, or a history of recent pain at the site of injury.

Management of Bleeding:

Management of external bleeding.

- Conduct primary / secondary survey & record observations.
- Classify bleeding:
  - Compressible / Non-Compressible.
  - Arterial / venous / capillary.
  - Category of shock (Compensated / Non-Compensated).
- Any patient with blood loss that is over 10% should be treated for hypovolaemic shock.
- Control bleeding using **stepped** approach:
  - **Elevation:**
    Keeping the wound above the level of the heart will decrease the pressure at the point of injury, and will reduce the bleeding. This mainly applies to limbs and the head.

Elevation

  - **Direct / Indirect Pressure:**
    Placing direct pressure on the wound with a field dressing will constrict the blood vessels manually, helping to stem any blood flow. Placing indirect pressure (pressure to the artery supplying a limb, such as femoral / brachial) can stem the flow.
    Regardless of which pressure is applied, time & force are the most critical factors. The aim is to allow clot aggregation; therefore a minimum of 3 minutes of pressure must be given (it is possible to apply pressure for up-to 30 minutes) at a force greater than arterial pressure (120mmHg).

Direct Pressure

  - **Tourniquet:**
    The decision to use a tourniquet on a hemorrhaging limb is taken after: elevation / pressure have failed or if the limb is so catastrophically injured that these measures are impossible.

Tourniquet

- Implement compromised airway management.
- Implement hypovolaemic shock management.
- Manage the wound using sterile a pressure dressing (see wound management section).
- Continually assess casualty.
- If the casualty does not recover quickly or you are unsure inform duty medic.

Management Of Internal Bleeding:

- **EMERGENCY** casualty will require urgent surgical intervention.
- Contact medical support.
- Implement Compromised Airway Management.
- Prepare to evacuate (As per vessel S.O.P's).
- Manage the wound using sterile a pressure dressing (see wound management section).
- Implement Shock Management.
- Continually assess casualty & record observations.

Pressure Dressing

Abdominal Dressing

Management of haemorrhage in divers / swimmers

There are several key factors to consider when dealing with blood loss in the diving industry.

Diving Gear

It is extremely difficult to evaluate volume of blood-loss in the water and very hard to detect bleeding in a diver wearing a dry suit or wet suit.

Systemic Vascular Resistance

The divers suit may be cut off to deal with any injury, however when a divers suit is suddenly removed there can be a dramatic drop in systemic vascular resistance. This reduces the perfusion of blood to the central organs and increases the blood flow to the peripheries. This normal effect is easily compensated for when the diver is fit. However if the diver is suffering from shock (particularly neurogenic shock) this drop in vascular resistance can have profound cardiovascular effects that will increase the severity of shock.

The Effects of Water On Clot Formation

The normal fibrin mesh / platelet aggregation process of blood clotting is greatly inhibited when an open wound is wet thereby washing away the body's attempt to 'plug the hole'. Therefore if a diver has an active bleed whilst wearing a hot water suit, the actual flowing water will actively wash away any clot formation

Electric Shock 4.5 (Electrocution)

Death by electricity is called "electrocution", other effects are called electric shocks.

Volts V Amps

It is usual to say that "amperes kill and volts burn". In fact, other factors explain these accidents and their several manifestations.

Intensity causes immediate clinical signs. It depends on the voltage of the current and the resistances according to the relation I = U/R (U=voltage in volts; R= resistances in ohms; I=intensity in Amperes).

Resistances to the current vary, depending on; the path they take (body and cutaneous resistances can vary), clothes (serial resistances), moisture (low resistances). This explains that for the same voltage, the effects of the current can be variable. A 1 milliampere intensity produces a simple jolt; the muscular contraction appears near about 10 milliamperes; an 80 milliampere current can create a cardiac arrest.

The voltage which vary from 110 to 250 000 volts or more, is the second important point, its action being due to the Joule effect releasing heat and causing burns;

Current	Reaction
.001 Ampere	Perception level. Just a faint tingle.
.005 Amperes	Slight shock felt; not painful but disturbing. Strong involuntary reactions to shock can lead to injuries.
0.006 - 0.025 Amperes (women)	Painful shock, muscular control is lost.
0.009 - 0.030 Amperes (men)	This is the freezing current or let-go range.
0.050 - 0.100 Amperes	Extreme pain, respiratory arrest, severe muscular contractions. Individual cannot let go. Death is possible.
1 - 4.3 Amperes	Ventricular fibrillation. Muscular contraction and nerve damage occur. Death is most likely.
10 Amperes	Cardiac arrest, severe burns and probable death.

Presentation of Electrical Shock:

They are numerous and quite different according to the type of current:

- Low voltage currents (50 to 380 volts) create an immediate vital risk because of the cardiac and respiratory disruptions.
- High voltage cause further serious and deep burns.

Cardiovascular Effects

- Ventricular fibrillation : especially due to the low intensity current (less than 4 amperes) with a path crossing the heart (from arm to arm; or from head or arm to leg).
- Other cardiac consequences : excitability troubles (extra-systole), conduction troubles, temporary repolarisation troubles can be seen in the ECG several days after a serious electric shock. Arterial spasms and thrombosis.

Muscular Actions

Severe muscular contractions can occur when alternating current is used.

- The casualties' hand may spasm fixing it to the contact point or more rarely projected away causing trauma (high voltage).
- Thoracic and diaphragmatic muscles contractions can involve difficulty and even complete respiratory arrest.
- Large muscular damage may result if the shock wave passes through a large muscle group. The resulting damage my result in Rhabdomylosis (crush injury syndrome).

Burns

Because of their depth, high voltage current can produce serious burns, reaching muscle tissues, vessels and nerves (whose electric resistance is low).

High Voltage: Lightning / Arc Welding Injuries

This may be direct exposure or indirect exposure (upto 1000 meters from a lightning impact). Clinical manifestations include: Cardiac arrhythmias, rhabdomylosis, neurological signs: amnesia, lack of orientation, or in more serious cases, different levels of coma or temporary neurological stroke and burns.

Management of Electrical Shock:

- SAFE approach.
  - Maintain 'ARC Cordon' if high voltage exposure.
  - Ensure electrical source isolated.
- Conduct primary / secondary survey & record observations.
- Implement compromised airway management.
- Contact medical support.
- Manage any wounds / burns (see wound / burn management section).
- Implement shock management.
- Monitor and assess casualty.
  - If no cardiac disturbances are present 1 hr after electrocution it is safe to assume cardiac stability.
- Prepare to evacuate (As vessel S.O.P's).

DISABILITY / NEUROLOGY (Central Nervous System) 5

Injuries to the head often lead to unconsciousness, which in turn compromises the airway. Permanent damage to the brain may result from a head injury.

Concussion 5.1 (A.T.O.M.F.C.)

Concussion is a condition caused by 'shaking' of the brain. The brain is cushioned within the skull by 'cerebro-spinal fluid', so if the head receives a blow the brain can bounce from one side to the other, causing widespread disruption to its normal electro-chemical functioning.

Concussive Injury

Presentation of Concussion:

- Brief or partial loss of consciousness *(usually less than 3 minutes).*
- Blurred vision.
- Dizziness / dazed.
- Loss of memory.
- Personality change / slurred speech.
- Stiff neck.
- Nausea & vomiting.
- Consistent mechanism of injury.

Concussive Head Injury

Management of Concussion:

- Contact medical support.
- Conduct primary / secondary survey & record observations.
- Reassess regularly. (Use neuro exam including AVPU /GCS). If the casualty's conscious level is severely reduced (G.C.S. ≤ 8, only responding to Pain in AVPU).
  - Implement compromised airway management.
  - Implement shock management.
- Continue to monitor concussion casualty if:
  - There has been any period of unconsciousness.
  - There is gross nausea.
  - There are personality changes.
  - For the next few days, the casualty should be reviewed by the duty medic.
- Prepare to evacuate (as per vessel S.O.P's).

Open & Closed Head Injuries 5.2 (Skull Fractures / Cerebral Compression) (A.T.O.M.F.C.)

The skull, like any bone may fracture if enough force is applied. A skull fracture is serious because the broken bone may directly damage the brain, or cause bleeding, which in turn results in cerebral compression.

In cerebral compression the brain is placed under extreme pressure, caused by bleeding or swelling in the closed cranial cavity.

Open Head Injuries:

Penetrating Skull Injury

An open head injury is always caused by trauma, either blunt injury or penetrating.

- There is a significant risk of damage to the brain and the cerebral vascular supply.
- Infection is a real risk. External bacteria may contaminate the brain, causing encephalitis or the surrounding meninges, causing meningitis.

Closed Head Injuries:

A closed head injury is also generally traumatic.

- There is a reduced chance of infection & probable direct trauma.
- However there is no 'release' of accumulated pressure.
- Cerebral compression may occur due to an increase of pressure in the brain. This pressure may be due:
  - An accumulation of blood / fluid within the skull.
  - Swelling of injured brain tissues.
- Cerebral compression may also be caused by:
  - Hemorrhagic stroke.
  - Infection.
  - Space occupying lesion.

Compressive Injury

Presentation of Cerebral Compression / Skull Fracture:

- Visible injury.
- Consistent mechanism of injury.

- Possible concussion.
- Watery / blood streaked fluid coming out of the ear / nose.
- Confusion / reduced conscious level / airway compromise.
- Generalised clonic / tonic seizure.
- Unequal pupils (caused by an increased pressure in on cerebral hemisphere).
- Slow strong pulse (a sign of medulla oblongata compression).
- Noisy slow breathing (a sign of medulla oblongata compression).
- Bilateral dilated pupils (also known as coning, a sign of medulla oblongata **terminal** compression).

Increased Intracranial Pressure On One Hemisphere

Increased Intracranial Pressure On BOTH Hemispheres

Management of Concussion, Compression or Skull Fracture:

- Contact medical support (*URGENTLY* if the casualty has been unconscious, their levels of response deteriorate, or you suspect fractured skull).
- Conduct primary / secondary survey & record observations.
- Reassess regularly. (Use neuro exam including AVPU /GCS).
- Suspect cervical injury and instigate immobilisation measures.
- If the casualty's conscious level is severely reduced (G.C.S. ≤ 8, only responding to Pain in AVPU).
  - Implement compromised airway / breathing management.
- Implement shock management.
- Manage seizures.
- Prepare to evacuate (as per vessel S.O.P's).
- Control bleeding by applying gentle pressure around the wound, but if there is bleeding or discharge from an ear, don't try to plug the ear or stop it bleeding.
- Manage any wounds (see wound management section).
- Look for and treat any other injuries.

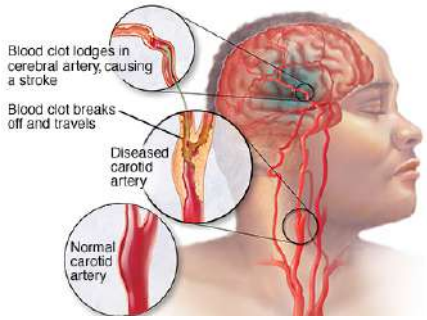
WARNING! Nasopharangeal airways can be dangerous in casualties with basal skull fractures. There is a potential of pushing the airway through a fracture into cerebral tissue.

Stroke 5.3 (Cerebro-Vascular Accident) (A.T.O.M.F.C.)

A stroke (Cerebro-Vascular Accident - CVA) is the rapidly developing loss of brain function due to disturbance in the blood supply to the brain.

There Are 3 Main Causes:

Types Of Stroke



Thrombotic Stroke

In thrombotic stroke, a thrombus (blood clot) usually forms around atherosclerotic plaques. Since blockage of the artery is gradual, onset of symptomatic thrombotic strokes is slower. A thrombus itself (even if non-occluding) can lead to an embolic stroke. The effects are intermittent and cause a Transient Ischemic Attack (TIA).

Embolic Stroke

This is blockage of a cerebral artery by an embolus, a travelling particle or debris in the arterial bloodstream originating from elsewhere. There are several things, which may cause an emboli, they include:

- A thrombus (From an atherosclerotic plaque or Deep Vein Thrombosis - DVT).
- Fat Embolism (in a large fracture, the fatty bone marrow may leak into the circulation).
- An Arterial Gas Embolism.
- Emboli from tumor cells or clumps of bacteria.

F.A.S.T. Stroke Symptoms

Haemorrhagic Stroke

A cerebral bleed. This may be trauma related, or a spontaneous aneurism rupture. The bleed causes compression of tissue from an expanding collection of blood. This can distort and injure tissue. In addition, the pressure may lead to a loss of blood supply to affected tissue with resulting infarction.

Presentation Of Stroke:

If you suspect stroke you should carry out the 'FAST' test:

FACIAL Weakness (Can the person smile? Has their mouth or eye drooped?).
ARM Weakness (Can the person raise both arms and hold them parallel?)
SPEECH Problems (Can the person speak clearly and understand what you say?)
TIME to medical help (If they fail any test, a stroke is a medical emergency).

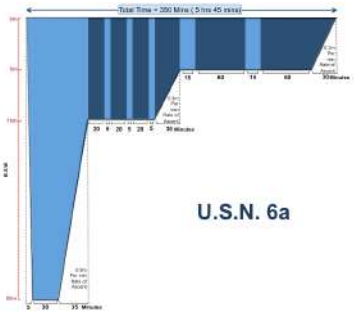
Other Signs And Symptoms To Look For Include:

- Loss of balance or coordination.
- Sudden severe headache / confused and emotional state.

- Impaired vision in one or both eyes.
- Unequal pupil size.
- Loss of bladder or bowel control.

Management Of A Stroke

- Contact medical support (*URGENTLY* if there has been unconscious, their levels of response deteriorate, or you suspect fractured skull).
- Conduct primary / secondary survey & record observations. (Use neuro exam including AVPU /GCS).
- If the casualty conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU).
  - Implement compromised airway / breathing management.
- If casualty has recently dived be highly suspicious of a C.A.G.E.
  - If suspected follow company S.O.P. (Typically USN Table 6a).
- Implement supportive measures:
  - Lay the conscious casualty down, with head and shoulders raised.
  - Reassure the casualty - do not assume that they don't understand.
  - Support any paralyzed limb.
  - Do not give anything to eat or drink.
- Look for and treat any other injuries.
- Prepare to evacuate (As per vessel S.O.P's).
- Reassess neurology regularly.



Seizures 5.4 (A.T.O.M.F.C.)

A seizure, occasionally referred to as a fit, is defined as a transient symptom of "abnormal excessive or synchronous neuronal activity in the brain". The outward effect can be as dramatic as a wild thrashing movement (generalised clonic-tonic seizure) or as mild as a brief loss of awareness.

It can manifest as an alteration in mental state, convulsive movements, and various other symptoms (such as déjà vu). The medical syndrome of recurrent, unprovoked seizures is termed epilepsy, but seizures can occur in people who do not have epilepsy.

Generalized Seizure

The Causes Of Seizures Include:

- Epilepsy.
- Hypoxia (due to reduced cerebral perfusion: shock / cardiac arrest).
- Gas toxicity (including oxygen toxicity).
- Stroke.
- Metabolic Imbalance (including acid-base / glucose / electrolyte disturbances).
- Drug toxicity.
- Trauma (bleeding or general raised intracranial pressure due to odaema).
- Infection (localised infections: encephalitis – meningitis. Or systemic: septicemia).
- Space occupying lesion (tumor, abscess, bleeding).
- Febrile convulsion's (common in young children, due to immature hypothalamus).

Types of Seizures

Out-dated terms such as "petit mal", "grand mal", "Jacksonian", "psychomotor", and "temporal-lobe seizure" have fallen into disuse.

It Has Become Common Practice To Break Seizures Down Into 2 Main Distinctions:

Partial or Focal Seizures

These are seizures, which affect only a small region of the brain. Casualties tend to retain consciousness. Partial seizures are often precursors to larger seizures, where the abnormal electrical activity spreads to a larger area of (or all of) the brain, resulting in a generalized seizure. They are often known as an aura.

Déjà vu is actually a partial seizure, it is an aberrant rerouting of a current experience through a memory portion of the brain, giving the sufferer the impression that they have experienced the situation previously.

Generalized Seizures

This type of seizure impairs consciousness and distorts the electrical activity of the whole or a larger portion of the brain. Generalized seizures can be sub-classified into a number of categories, depending on their behavioural effects:

- **Absence Seizure.** An interruption to consciousness, the person experiencing the seizure seems to become vacant and unresponsive (usually up to 30 seconds). Slight muscle twitching may occur.
- **Myoclonic Seizure.** Involve an extremely brief (< 0.1 second) muscle contraction and can result in jerky movements of muscles or muscle groups.
- **Atonic Seizures.** Involves the loss of muscle tone, causing the person to fall to the ground. These are sometimes called 'drop attacks' but should be distinguished from similar looking attacks that may occur in narcolepsy or

cataplexy.

- **Clonic-Tonic Seizure.** It involves an initial contraction of the muscles (**clonic phase**), which may involve tongue biting, urinary incontinence and the absence of breathing. This is followed by rhythmic muscle contractions (**tonic phase**). This type of seizure is usually what is referred to when the term 'epileptic fit' is used colloquially.

Management of Partial Seizure:

- Remove any sources of danger, such as a knife or hot drink in their hands.
- Help the casualty to sit down in a quiet place and reassure them.
- Inform / contact medical support.
- Assess casualty & record observations. (Use neuro exam including AVPU / GCS).
- Stay with the patient until they are fully alert.
- Ensure that any partial seizure is *INVESTIGATED*, making sure it is not 'shrugged off' by a casualty.

Management of Generalized Seizure:

The following management is aimed at the more typical clonic-tonic seizure.

During The Seizure:

- Maintain safety:
  - Help the casualty to the floor to avoid injury if possible.
  - Gently cushion the patient's head to help avoid injury.
  - Loosen any tight clothing around the neck to help the patient breathe.
  - Move any objects that may harm the casualty and ask bystanders to move away.
- If you are concerned about the airway, roll the casualty onto their side.
- Take note of the exact time the seizure started and its duration.
- Look for probable causes of the seizure.

Make An Urgent Medical Call If:

- The seizure lasts more than 3 minutes.
- The patient's levels of response do not improve after the seizure within 10 minutes.
- The patient has a second seizure.
- The patient is not diagnosed as epileptic or this is their first seizure.

NEVER place anything in the casualty's mouth (especially your fingers!).

NEVER try to hold the patient down or restrain them.

NEVER move the casualty (unless they are in danger).

As Soon As The Seizure Stops:

- Contact medical support. (*URGENTLY* if the casualty has been unconscious, their levels of response deteriorate).
- Conduct primary / secondary survey & record observations. (Use neuro exam including AVPU /GCS)
- If the casualty's conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU).
  - Implement compromised airway / breathing management.
- Implement Shock Management as appropriate.
- If casualty has recently dived be highly suspicious of a gas toxicity hit or C.A.G.E..
  - If suspected follow company S.O.P. (Typically USN Table 6a for C.A.G.E., Cessation of O_2).
- Look for and treat any other injuries / cause of seizure.
- Prepare to evacuate (As per vessel S.O.P's).
- Reassess neurology regularly.
- Consider urethral catheterization if neurology remains reduced.

MUSCULO-SKELETAL DISORDERS 6

Sprains & Strains 6.1

A sprain is defined as an injury to a ligament at a joint. A strain is defined as an injury to muscle. Usually caused by sudden wrenching movements.

Sprains Are Graded 1, 2 Or 3 Depending On Severity:

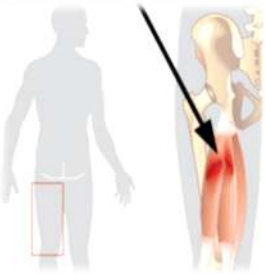
Grade 1 Sprain (First Degree)
The most common and requires the least amount of treatment and recovery. The ligaments are often over-stretched, and damaged microscopically, but not actually torn. The ligament damage has occurred without any significant instability.

Grade 2 Sprain (Second Degree)
Is more severe and indicates that the ligament has been more significantly damaged, but there is no significant instability. The ligaments are often partially torn.

Grade 3 Sprain (Third Degree)
This indicates that the ligament has been significantly damaged, and that instability has resulted. The ligament has been torn or completely avulsed.

Sprain

Muscular Strain



Strains Are Also Graded 1, 2 Or 3 Depending On Severity:

Grade 1 Strain: (First Degree)
Consists of minor tear or bruising within the muscle.

Grade 2 Strain: (Second Degree)
This is a partial tear of the muscle.

Grade 3 Strain: (Third Degree)
A severe or complete rupture or avulsion of the muscle.

Presentation of Sprains & Strains:

- Pain (the limb hurts and is difficult to move).
- Bruising or swelling over injury site.
- A burning sensation in the area of the injury.
- Muscle cramp or spasm.
- A possible audible "popping" at time of injury.
- A gap, dent or other defect in the normal outline of the muscle.

Remember: minor fractures can easily be mistaken for sprains and strains. The only way to *rule out* a fracture is by actual x-ray.

Management of Sprains & Strains:

The best treatment for a sprain or strain is to follow the **R.I.C.E.** mnemonic:

- **R**est. Rest the injury.
- **I**ce. Apply an ice pack to the injury (this helps to reduce swelling). Apply for 10 minutes, every 2 hours, for 24 hours.
- **C**ompression. Apply a firm (not constrictive) bandage to the injured area. This reduces swelling. The bandage can be applied over a ice pack for the first 10 minutes.
- **E**levation. Elevate the injury. This reduces swelling by aiding venous return.
- Analgesia management (see medication section).

R.I.C.E. Therapy

Dislocations 6.2

A dislocation is where a bone becomes partially or fully dislodged at a joint, usually as a result of wrenching movement or sudden muscular contraction. The most common dislocations are the kneecap, shoulder, jaw, thumb or a finger.

There may also be a fracture at or near the site of the dislocation, and damage to ligaments, tendons, cartilage and muscles.

It can be difficult to distinguish between a fracture and a dislocation.

Presentation of a Dislocation:

- Deformity & inability to move the dislocated area.
- Pain & tenderness in the injured area.
- Swelling in the injured area.
- Difficulty using or moving the injured area in a normal manner.
- Discolouration, warmth, bruising, or redness in the injured area.
- An associated sprain / strain injury.

Dislocated Shoulder

Management of a Dislocation:

- Contact duty medic / supervisor. (*URGENTLY* if the dislocation is interrupting blood or nervous supply).
- Conduct primary / secondary survey & record observations.
- R.I.C.E. management.
- Treatment is usually closed reduction as soon as possible, it requires:
  - A medic capable of undertaking closed reductions.
  - Anaesthetic sedation (normally I.V. propofol).
  - Opiate level analgesia (normally I.V. fentanyl or morphine).
  - Personnel who can apply compromised airway / breathing management precautions.
- Implement shock management as appropriate.
- Do not give anything to eat or drink until medically reviewed.
- Place limb in a supported sling.
- Look for and treat any other injuries.
- Prepare to evacuate (as per company / vessel S.O.P's).

Closed Reduction

Fracture 6.3

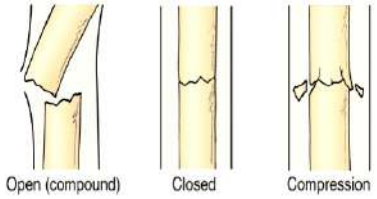
Injury can be caused to the bones, muscles and joints by different types of force.

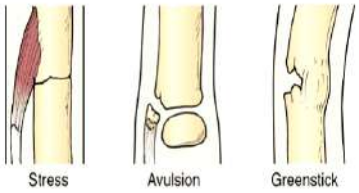
These Are:

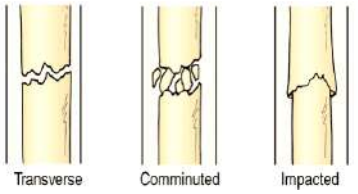
- Direct Force. Damage results at the location where the force was applied, e.g. as the result of a blow or kick.
- Indirect Force. Damage occurs away from the point where the force, e.g. a fractured collar bone, due to an outstretched arm.
- Twisting Force. Damage results from torsion forces on the bones and muscles, e.g. 'twisting an ankle'.
- Pathological. Injury results because the bones have become brittle or weak, due to disease or old age.

A fracture can be defined as a 'break in the continuity of the bone'.

Types Of Fractures







The Basic Categories Of Fracture Are:

- Closed (Simple) This is a break or crack in the bone, with no complications. It may be divided into:
  - Linear Fracture: The fracture is parallel to the bone's long axis.
  - Transverse Fracture: The fracture is at a right angle to the bone's long axis.
  - Oblique Fracture: The fracture is diagonal to a bone's long axis.
  - Spiral Fracture: At least one part of the bone has been twisted.
- Incomplete Fracture: The bone fragments are still partially joined.
- Open (Compound): The bone has broken the skin, which may (or may not) still be protruding from the wound. This type of injury has a high risk of infection.
- Compression Fracture: A closed fracture that occurs when two or more bones are forced against each other. Common in spinal injuries.
- Stress Fracture: It is a common overuse injury. It is most often seen in athletes who run and jump on hard surfaces.
- Avulsion Fracture: A closed fracture where a piece of bone is broken off by a sudden, forceful contraction of a muscle. Common in athletes and can occur when muscles are not properly stretched before activity.
- Green Stick: The bone is split, but not totally severed. Green Stick fractures are often mistaken for sprains and strains, because only a few of the signs and symptoms of a fracture are present. Common in children.
- Comminuted (Multi-fragmentary fracture): In this the bone splits into multiple pieces.
- Complicated: With this type of injury, there are complications, which have arisen as a result of the fracture, such as trapped blood vessels or nerves.
- Impacted Fracture: An impacted fracture is similar to a compression fracture, yet it occurs within the same bone. It is a closed fracture, which occurs when pressure is applied to both ends of the bone, causing it to split into two fragments that jam into each other.

Presentation of a Fracture:

- Pain at the site of the fracture. Strong analgesia or nerve damage may mask the pain.
- Loss of C.S.M. at or distal to the injury:
  - **C**olour: Suggesting there may be vascular impairment.
  - **S**ensation: Suggesting that there may be nervous damage.
  - **M**ovement. Suggesting that there may be muscular / tendon involvement..
- Unnatural movement. An 'unstable fracture', care should be taken to prevent the fracture from moving.
- Swelling or bruising. Dramatic muscular damage may cause **compartments syndrome** or **hypovolaemic shock**.
- Deformity. If a leg is bent at a 90º angle, it's broken!
  - Irregularity Lumps or depressions. Along the surface of the bone, where broken ends of the bone may overlap.
- Crepitus. The feeling and sound of bone grating on bone when broken ends rub on each other.
- Pulmonary Emboli: Large bone fractures (femur, pelvis) carry a risk of releasing a fat embolism from the bone marrow.

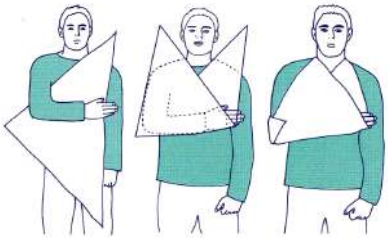
Management of a Fracture:

- Contact medical support. (*URGENTLY* if there are signs of shock, P.E. or C.S.M. impairment).
- Conduct primary / secondary survey & record observations.
- Reassure the casualty, limit limb movement.
- Implement compromised airway / breathing management as necessary.
- Implement Shock Management as appropriate. (O_2, I.V.I. Etc).
- Implement bleeding management as appropriate.
- Implement wound management as appropriate.
- Keep injury still with your until it is properly immobilised.
  - The casualties might be able to do this on their own.
- Don't let the casualty eat or drink (they may need an operation).
- Implement R.I.C.E. management.
- Give analgesia in-line to pain level (& instructions of medic).
- Look for and treat any other injuries.
- Prepare to evacuate (As per vessel S.O.P's).

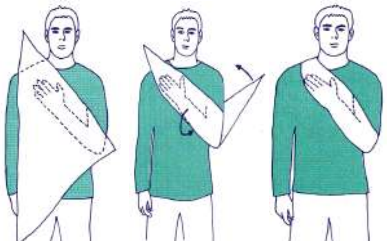
For A Limb Injury:

- Place the arm in a sling against the trunk of the body.
- Arm fractures are normally placed in a support sling.
- Collar-bone fractures are normally supported by elevated sling (keeping the elbow down at the patient's side).
- SAM Splints may be very useful to aid immobilization.
- Check circulation and sensation beyond the injury.
  - Use manual traction with **Extreme** caution.

Support Sling



Elevated Sling



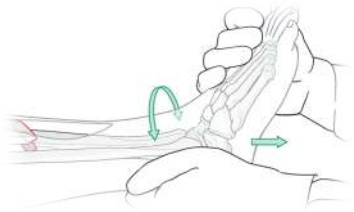
SAM splint

Traction

Traction is usually used to align a bone or bones by a gentle, steady pulling action. It is used to: alleviate pain and re-establish blood supply / nerve conduction. The pulling force may be transmitted to the bone through skin tapes or a manual pulling.

Traction may be used as a preliminary treatment, before other forms of treatment. The use of traction by the untrained medic should be for life or limb saving reasons only. There is a danger that traction of a limb could make a neuro-vascular problem worst.

Manual Traction

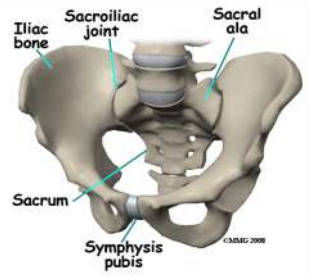


Pelvic Fracture 6.3.1

Fracture of the pelvis has the greatest mortality rates of skeletal injury.

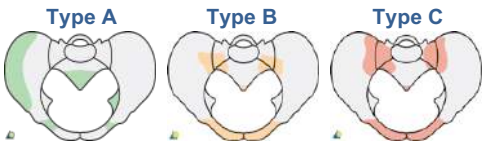
- Overall pelvic fracture mortality: 16%.
- Closed pelvic fracture and hemodynamical instability mortality: 27%.
- Open pelvic fracture mortality: 55%.

The main reason for such a high mortality rate is due to the passage of major arteries & veins and the highly vascular nature of the pelvic bone itself. Therefore direct injury is likely to cause large blood loss and secondary damage to the vessels passing through the cavity resulting in large retroperitoneal bleeding.



Classification of a Pelvic Fractures:

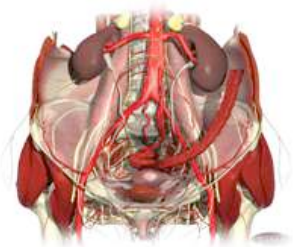
- Type A. (Stable) Minimally displaced.
- Type B. (Partially Stable) Incomplete disruption of posterior arch. Open book injury (external rotation). Internal rotation ("bucket-handle") Usually mechanically stable. External rotation injury can be unstable.
- Type C. (Unstable) unilateral complete disruption of one or both arch's. **All**
- are mechanically unstable.



Injury To The Pelvis Is Also Associated With Other Injuries:

- Femoral Vessel disruptions.
- Sacral nerve injuries.
- Rectal perforation.
- Vaginal perforation.
- Bladder and vesical injuries.
- Spinal injuries.
- Femoral fractures.
- Long-term disability.

Internal Pelvic Structures



Presentation of a Pelvic Fractures:

- Pelvic tenderness.
- Pelvic instability - gentle compression (Once).
- Haematuria / blood at urinary meatus.
- Abdominal / Flank / Pelvic bruising.
- Perineal / scrotal haematoma.

Pelvic Bruising

Scrotal Bruising

Management of a Pelvic Fracture:

- Implement fracture management as appropriate.
- Evaluate site for blood loss & implement haemorrhage control.
- Immediate pelvic stabilisation.
  - Pelvic stabilisation device.
  - Improvised pelvic wrap.
- Urgent surgical intervention.
  - External fixator.

Pelvic Stabilisation Sling

Pelvic Wrap

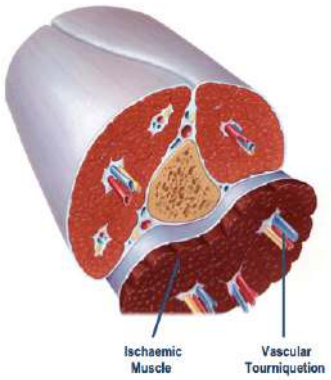
Compartment Syndrome 6.4

Compartment syndrome occurs when swelling of the muscles in muscle compartment (generally in a limb) suffer increased pressure in the tissues and eventually swell to the point that blood supply is stopped.

The condition is trauma related, either direct injury to the muscle, which causes rupture of the tissues & blood vessels or indirect: such as a fracture of the limb where the bone lacerates muscular tissue. Normally it present in large muscular limbs (the forearm, calf or thigh) but it has been observes in smaller muscular compartments (hands, feet & buttocks).

The Process Of Compartments Syndrome Follows A Logical Path:

- Initial traumatic injury.
- Bleeding / swelling of a closed muscular sheath.
- Venous tourniquetion (reducing the venous return from the sheath, increasing swelling).
- Localised tissue ischemia (causing anaerobic metabolism, which increases swelling).
- Increased tissue swelling (and decreased muscle perfusion).
- Arterial Tourniquetion.
  - If ischemia continues, muscle and nerve tissues die, causing permanent loss of function.
  - Muscle damage will be irreversible after 4-6 hrs.
  - Nerve damage will be irreversible after 12-24 hrs.



The overall effect of compartments syndrome is identical to arterial tourniquetion. Time is the most critical factor, if untreated tissue death will occur.

There is also the relative risk of rhabdomyolysis once the condition has been alleviated. It is for this reason that compartments syndrome is always treated as an emergency.

Presentation of Compartment Syndrome:

The definitive presentation of the syndrome is identified with the six 'P's':

- **Pressure;** Early finding & only objective finding. Refers to palpation of compartment and its tension or firmness.
- **Pain;** Classically out of portion to injury. Exaggerated with passive stretch of the involved muscles. May be masked with analgesia.
- **Paresthesia;** An early sign. Peripheral nerves are sensitive to ischemia. Damage occur in 75 minutes.
- **Pallor;** Indicates direct damage to vessels rather than compartment syndrome.
- **Pulselessness;** Indicates direct damage to vessels rather than compartment syndrome.
- **Paralysis;** Very late finding (Irreversible nerve and muscle damage present).

Pain
Out Of Proportion To Injury

Further signs of Compartments Syndrome:

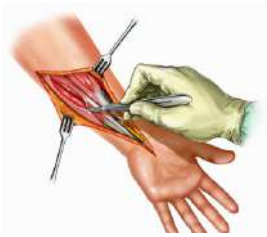
- Consistent mechanism of injury.

Management of Compartment Syndrome:

- Contact medical support. (*URGENTLY* if there are signs of shock or C.S.M. impairment).
- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management as necessary.

- Implement fracture management as appropriate.
- Evaluate site for blood loss & implement haemorrhage control.
- Reassure the casualty, limit limb movement.
  - Maintain the limb to neutral alignment.
  - Splint the limb.
- Loosening an external constriction, such as:
  - A tight bandage.
  - Splitting a cast.
  - Remove restraining clothing.
- Prepare to evacuate (As per vessel S.O.P's).
  - Casualty will require an urgent surgical fasciotomy (an opening of the muscle facia to release the pressure).
- Monitor for & implement rhabdomyolysis therapy as instructed.

Surgical Fasciotomy



Rhabdomyolysis 6.5 (Crush Injury Syndrome)

Rhabdomyolysis is a condition in which damaged skeletal muscle tissue breaks down rapidly. Breakdown products of damaged muscle cells are released into the bloodstream; some of these, such as the protein myoglobin, are harmful to the kidneys and may lead to kidney failure.

Crush injuries most commonly occur as a result of environmental, industrial or traffic accidents. Blood flow to a limb (e.g. an arm or a leg) is impaired by the weight of a crushing object. Rhabdomyolysis may also be caused by a sudden release of a tourniqueted limb, as in arterial tourniquetion or Compartment Syndrome.

If the blood flow to the limb is impaired for 2hrs or more, the toxins will build up so that if they are released into the systemic circulation (which will happen when the crushing object is removed). The circulating 'damaged' muscular debris can have dramatic effects; there will be a sudden release of the electrolyte potassium (which can cause **cardiac arrest**), the debris is generally toxic, which will cause an inflammatory response and in an attempt to excrete the debris it is common for the myoglobulin to swamp or 'clog' the glomerulus of the kidney causing acute renal failure.

Presentation of Rhabdomyolysis:

- Presence of causative agent (Limb crushed, application of tourniquet, compartment syndrome).
- Cardiac disturbances (irregular, rapid pulse).
- Urine disturbances.
  - Urine output ≤ $^1/_2$ ml per kg (on average urine output should be 40ml per hr).
  - Urine is dark & 'coke cola' coloured.
  - The urine has excessive 'foam'. (Due to the myoglobulin proteins).
- Excessive nausea & vomiting.

Rhabdomyolysis Urine

Management of Rhabdomyolysis:

Treatment For Crushing Less Than 2 Hours:

- Release the casualty as quickly as possible if you can.
- Conduct primary / secondary survey & record observations.
- Implement compromised airway management.
- Contact medical support.
- Prepare to evacuate (As per vessel S.O.P's).
- Manage bleeding.
- Manage any wounds (see wound management section).
- Implement shock management
- Closely monitor and assess casualty for cardiac and renal disturbances.

Treatment For Crushing More Than 2 Hours:

- DO NOT release the casualty.
- Contact medical support.
- Conduct primary / secondary survey & record observations.
- Manage pain.
- Manage bleeding.
- Manage any wounds (see wound management section).
- Implement shock management.
- Monitor casualty until ready to remove crushed limb (attach cardiac monitor if available & insert urethral catheter).
- Release crushed limb.
  - Closely monitor A.B.C.D.E's.
  - Observe urine (for classic signs).
- Prepare to evacuate (As per vessel S.O.P's).

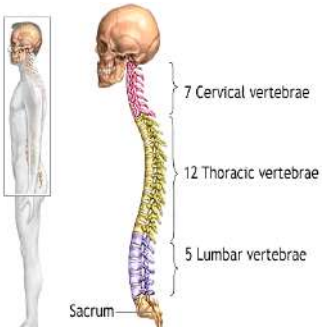
Spinal Injuries 6.6

Spinal injuries occur in approximately 2% of trauma patients. Although this figure is relatively low, suspecting and correctly treating the injury is essential, because poor treatment of a patient with a spinal injury could result in paralysis or even death.

The spinal cord is an extension of the brain stem, and travels down the back of the spinal vertebrae. Vital nerves, controlling breathing and movement of limbs travel down the spinal cord.

The weakest part of the spinal column is the neck, and indeed a neck injury can be the most severe type of spinal injury, because the nerves controlling breathing may become severed.

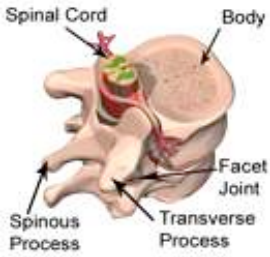
The Spine



Suspect Spinal Injury If The Casualty Has:

- Sustained a blow to the head, neck or back (especially with unconsciousness).
- Fallen from a height (≥ 2-3 times the victims height).
- Dived into shallow water.
- High velocity incidents (vehicle / machinery).
- Been involved in a 'cave in' accident (e.g. crushing, or collapsed environment).
- Multiple injuries.
- Pain or tenderness in the neck or back (pain killers or other severe injuries may mask the pain).

The Vertebrae

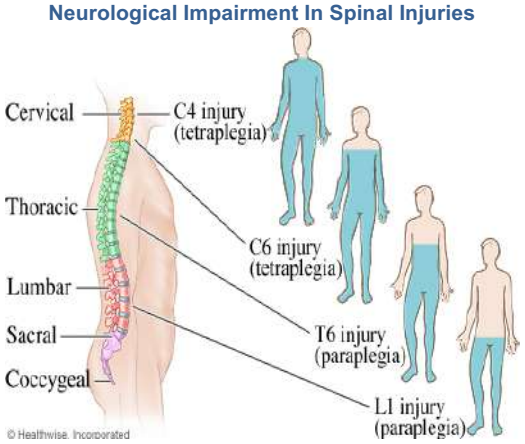


Presentation of a Spinal Injury:

Remember - if some of these signs and symptoms are present, nerves may already be damaged. You should treat a patient who you ***suspect*** has a spinal injury to *prevent* signs and symptoms from developing.

- Airway impairment (in high cervical spine injuries).
  - Pain or tenderness in the neck or back.
  - Signs of a fracture in the neck or back.
- Breathing difficulties.
  - Loss of breathing (in high cervical spine injuries).
  - Increased respiratory effort (low cervical / high thoracic injuries).
- Neurogenic Shock (Spinal).
- Neurological signs: (Dependent on site of spinal injury).
  - Loss of control / feeling of limbs (at or below the site of injury).
  - Altered sensations in the limbs (pins and needles or burning).
  - Incontinence.
  - Erection (priapism).
- History of spinal injury.
- Casualty unwilling to move.

Neurological Impairment In Spinal Injuries



Management of a Spinal Injury:

If The Patient Is Conscious:

- Reassure the patient. Instruct them not to move.
- Keep the patient in the position you find them.
  - Do not allow them to move, unless they are in severe danger.
- Implement manual in-line immobilisation.
- **Do not** move the patient unless they are in severe danger.
- Conduct primary / secondary survey (Use full neuro exam including AVPU / GCS).
- Apply spinal immobilization. (Stiff neck collar, head blocks, spinal board using log-rolling technique).
- Implement compromised airway / breathing management if required.
- Contact medical support. (*URGENTLY* if signs spinal / neurogenic shock).
- Implement shock management as appropriate.
- Implement bleeding management as appropriate.
- Implement wound management as appropriate.
- Give analgesia according to pain level & instructions of medic.
- Manage hypothermia. (Common in neurogenic shock).
- Look for and treat any other injuries.
- Prepare to evacuate (As per vessel S.O.P's).

In-Line Immobilisation

Full Spinal Immobilisation

The main priority of spinal care is to **'Do No Harm'**

If The Patient Is Not Breathing Normally Or Has A Reduced Conscious Level:

If the spinal injury is sufficiently high in the cervical vertebrae respiratory control may be affected. In addition head injuries are common in casualties with cervical injury.

If A Severely Reduced Respiratory Effort But A Normal Conscious Level /Are Present:

- Maintain spinal immobilization.

- Assist breathing with the use of a B.M.V. using High Flow O_2.
- Be prepared to clear airway with suctioning.
- Contact medical support (*URGENTLY* the casualty will require a tracheotomy at a medical facility).
- Prepare to evacuate (As per vessel S.O.P's).

If A Reduced Respiratory And A Reduced Conscious Level Are Present:

- Maintain spinal immobilization.
- Use the 'jaw thrust' technique to open the airway.
- If the casualty's conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU).
  - Protect airway with appropriate device (Naso-pharyngeal / Oro-pharyngeal airway).
- Assist breathing with the use of a B.M.V. using high flow O_2.
  - Prolonged maintenance ventilation will be required.
  - Sedation therapy is mandatory.
  - Be prepared to clear airway with suctioning.
- Closely monitor and manage cardiovascular system.
- Contact medical support. (*URGENTLY* as the casualty will require a medical facility).
- Prepare to evacuate (as per vessel S.O.P's).

Amputation 6.7 (A.T.O.M.F.C.)

Amputation is the complete or partial severing of a limb, or appendage (finger / toe), it is extremely traumatic and potentially life threatening due to the real possibility of rapid exsanguination by a catastrophic haemorrhage.

Amputated Hand

Presentation of Amputation:

- Fairly obvious missing limb or appendage.
- Uncontrollable haemorrhage.
- Hypovolemic shock.
- Reduced conscious level (cerebral hypoxia).

Management of Amputation:

- Manage bleeding.
  - Implement the stepped approach (it is common to quickly advance to tourniquetion if bleeding profuse).
  - For an amputated toe / finger, a band tourniquet over the base of the appendage may be used.
  - Indirect vascular pressure is very often useful.
- Contact medical support & prepare to evacuate (as per vessel S.O.P's).
- Conduct primary / secondary survey & record observations.
- Implement compromised airway management.
- Manage the wound (see wound management section).
- Implement shock management.
- Continually assess casualty.
- Manage pain.
  - Pain is generally overwhelming & sedation with airway control is often necessary.
  - For an appendage, a local anaesthetic block is very useful.
- Wrap the amputated part in a plastic bag (sterile if possible), and then put the package on a bag of ice to preserve it for transport to the hospital.
- Prepare to evacuate (As per vessel S.O.P's).

THE SKIN 7

It is assumed that an offshore worker with an important skin problem either can't pass the pre-employment physical or will bring their own medications for known problems.

Non-Infective Skin Disorders 7.1

The initial response should be to address the cause of the disorder.

The Problem May Be:

- A drug reaction.
- An Infective agent.
- Something in contact with the skin.
- Constant rubbing or scratching.

Healthy skin has a tremendous ability to heal itself without treatment if the provoking factor is removed.

Normal Preventative Measures:

- Avoid irritant medicines (discuss with remote doctor).
- Maintain a high standard of hygiene.
- Use protective garments.
- Ensure a good / balanced nutritional intake.
- Avoid suspicious jobs or areas.
- Cover the affected skin with a dressing or ointment.
- Stop scratching- Itching is a symptom seen in many different skin disorders and leads to scratching. Scratching causes release of chemicals from certain cells in the skin. These chemicals cause more itching, thus the "itch-scratch cycle".

Generic Treatments

These are useful for a variety of problems, perhaps in addition to more specific measures.

For Red, Itching, Oozing Skin:

- Soak the affected area:
  - Apply warm for infections, cool for other problems.
  - Soak hands or feet in a basin.
  - Apply a wet strip of towel or gauze to other body areas.
  - Apply for 15-30 minutes 2-3 times a day.

Anti-histamine Creams

The Following Are Soothing, Mixed With Ordinary Tap Water (Boiled & Then Cooled):

- Table salt, 10mg (2 teaspoons) per litre of water.
- Baking soda (sodium bicarbonate) 40mg (8 teaspoons) per litre of water.
- Epsom salt (magnesium sulfate) 40mg per litre of water.

For Severe Discomfort, These Interventions May Be Included:

- Diphenhydramine (or piriton) cream-apply a thin film over the area, cover with a dressing, repeat 4 times a day until improvement occurs, then begin simple soaks.
- Cortisone cream (and derivatives), apply the same as diphenhydramine.
- Oral medicines-These can be helpful for itching, especially during sleep. (They may cause drowsiness, so avoid or use with care around machinery or when operating equipment).
- Diphenhydramine-daytime 25-50 mg. every 4-6 hours, bedtime 50-100 mg.
- Dry skin: Apply any oily material such as lotion, petroleum jelly. An oily layer on the surface prevents evaporation of water and increases the moisture content of the skin.

Bacterial Skin Infections 7.2

Folliculitis (Barber's Itch)

This is most common on the face, the back of the neck, or in friction or rubbing areas. It may result from being shaved by unclean barber utensils.

The infected hair follicles result in many superficial pimples in the affected area.

Folliculitis

Management of Folliculitis:

- Inform duty medic.
- Initiate general principles & generic treatment.
- Open each pimple with the tip of a sterilised needle and scrub gently with soap.
- If not healed in 2-3 days, give oral antibiotics for 3-5 days as prescribed.

Boil (Furuncle)

Furuncle

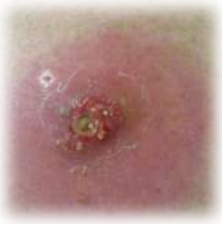
Usually due to an infection in a hair follicle, which penetrates deeper into the skin.

Management of Boils:

- Inform medic.
- Initiate general principles & generic treatment.
- Give antibiotics as prescribed.
- If the boil "comes to a head" with pus appearing in the centre in a soft area, open it with the tip of a sterilised needle and gently press out the pus.

Carbuncle

Carbuncle



A carbuncle is a collection of boils connected by channels under the skin. The most common location is the back of the neck. Often there is fever and spasm of the neck muscles. It may come to a head or drain at several points.

Management of Carbuncle's:

- Initiate standard boil treatment.
- Intravenous antibiotics may be needed.
- Paracetamol / ibuprofen to manage fever.
- Consider evacuation if the problem appears worse after 36-48 hours treatment.

Erysipelas (Holy Fire)

This is a strep infection of the skin, often on the cheek but can occur anywhere. It usually starts with a minor scratch or break in the skin.

Erysipelas

The skin is hot, red, thick or swollen and can often be indented with a fingertip. The typical appearance shows a sharp border between the infected and normal skin, which can be traced with a hall point pen and seen to advance in a few hours.

Management of Erysipelas:

- Contact medical support.
- Initiate general principles & generic treatment.
- Give antibiotics as prescribed. (It is usually better in 24-36 hours, healed in 3-5 days).
- Paracetamol / ibuprofen to manage fever.

Impetigo

Impetigo

This is a local infection of the skin caused and spread by bacteria from under the fingernails, usually due to scratching insect bites or minor skin irritations.

It starts as a small bump or blister-like area which turns into a honey-colored crust or scab with a "stuck-on" appearance. It itches but is not tender.

Management of Impetigo:

- Contact medical support.
- Initiate general principles & generic treatment.
- Minor cases usually heal by removing the crust, scrubbing with soap & covering.
- Have the patient cut his fingernails short and scrub the hands several times a day.
- For numerous lesions, more severe lesions give antibiotics as for folliculitis as prescribed.

Fungal Skin Infections 7.3

Fungal infections are relatively common in warm humid conditions such as a saturation chamber.

Generic Treatments Principles:

- Contact medical support.
- Maintain high standard of hygiene.
- The skin should be kept clean & dry.
- Wear loose garments and frequent changes of underwear or socks.
- Give anti-fungal medication as prescribed (tolnaftate, haloprogin, miconazole, clotrimazole).
- Apply the medicine 4 times a day or more often in severe cases until improvement is noted.

Tinea Pedis (Athlete's foot)

There is itching, burning or stinging between the toes and cracking and peeling of the skin. There may be deep, blister like areas in severe cases. Secondary infections are common in severe cases.

Athlete's Foot

Management Of Athlete's Foot:

- Inform medical support.
- Initiate general principles & generic treatment.
- If secondary infection present give antibiotics as perscribed along with the anti-fungal medicine.

Tinea Cruris (Jock Itch)

This is very common in humid climates. It starts in the crease between the scrotum and inner thigh, then spreads to those areas. On the thigh, the infected skin is dark pink or light brown with a definite border from normal skin. The first symptom is usually itching, later becoming tender and inflamed.

Jock Itch

Management of Jock Itch:

- Inform medical support.
- Initiate general principles & generic treatment.
- Jockey-type shorts should be avoided and the area should be kept clean and dry.

Tinea Versicolor

A harmless, but very common superficial infection. Seen on the upper portions of the chest, back and arms. It appears as light patches, which do not tan.

Commonly re-occurs in warm weather (then fades in the winter). Mainly a cosmetic problem.

Tinea Versicolor

Management of Tinea Versicolor:

- Inform medical support.
- Treat with dandruff shampoos containing selenium sulfide (apply for 10-20 mins then rinse).
- Repeat daily until better, then twice weekly.

Parasitical Skin Infections 7.4

A parasite is an organism that lives on or inside another organism (the host). Parasites usually enter the body through the mouth or skin. Parasites that enter through the mouth are swallowed and can remain in the intestine or burrow through the intestinal wall and invade other organs.

Parasites that enter through the skin bore directly through the skin or are introduced through the bites of infected insects (called vectors because they convey or transmit organisms that cause disease).

Lice

Head and body lice are usually due to poor hygiene but they spread readily in crowded quarters (even to people with good hygiene). Head lice nits can often be seen on shafts of the hair. Body lice are not usually seen but hide in seams of clothing. Pubic lice (crabs) may be seen or one may see tiny, dot-like droppings in underwear. Pubic lice are usually acquired during sexual activity.

Lice

Management of Lice:

- Inform medical support & Isolate casualty.
- Apply lindane lotion or shampoo as prescribed.
- For body lice, boil the clothing or wash in strong detergent.
- In some geographical areas, body lice may cause trench fever and typhus.

Scabies

A small mite, which burrows under the skin and lays eggs. It usually begins on the hands, wrist, feet and ankles.

It appears as small bumps or blisters, frequently seen in a pattern of lines or "runs". It itches most at night and spreads readily to close contacts.

Scabies

Management of Scabies:

- Inform medical support & Isolate casualty.
- Treat with lindane lotion (apply a thin layer. Leave on the skin 8-12 hours, then rinse off. Repeat in 5 days).
- Under-garments and bedclothes should be washed in a strong detergent.

Burns 7.5 (A.T.O.M.F.C.)

Burns are injuries to tissues caused by extreme temperatures (hot or cold), friction, electricity, radiation, or chemicals. Scalds are a type of burn caused by a hot liquid or steam.

Estimating The Severity Of A Burn

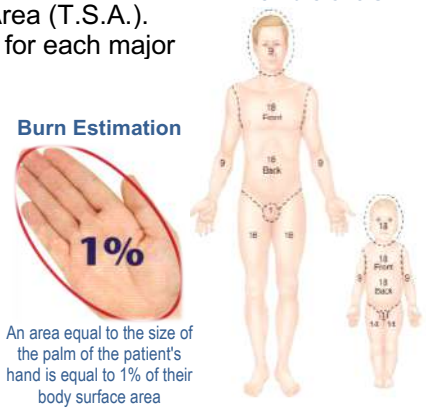
When a medic is dealing with a burnt casualty, it is essential to take into account the 6 factors that combine to affect the severity of a burn.

These are:

Size

The size of the burn is given as a percentage of the body's Total Surface Area (T.S.A.). The "rule of nines" is used to determine the total percentage of area burned for each major section of the body by breaking down total areas into 9% sections.

An easy way to estimate TBSA burned is to use the casualty's open hand (The palm of the casualy's opened hand is equal to 1% of their body area).



An area equal to the size of the palm of the patient's hand is equal to 1% of their body surface area

Cause

The cause of the burn influences the overall severity - for example, electrical burns may cause deep internal burns. Some chemicals (such as hydrochloric acid) cause poisoning in addition to burns.

Age

The age of the victim affects the recovery rate. Children will burn at lower temperatures than adults. Elderly casualty's burns take longer to heal and they may be more susceptible to infection.

As a predictor of overall mortality from a burn a rule of thumb is to add *Age + Percentage of Burn.* The closer to 100, the higher the mortality rate. For example, a 25 yr old with 14% burns is classed as severe but he would be expected to survive (the combined number is 39). However an 80yr old casualty with the same percentage burn would have a much higher mortality rate (combined % is 94).

Temperature

The intensity / temperature of a heat source combined with the duration of exposure dictate the overall severity of a burn.

43°c will cause cell breakdown in 6hrs, 96°c will cause a burn almost instantly.

Skin Temperature	Duration	Damage Caused
43°c	6 Hours	Cell breakdown begins
70°c	1 Second	Cell destruction
80°c	0.1 second	Curable burn (second-degree)
96°c	0.1 second	Incurable burn (third-degree)

Depth

The deeper the burn, the more the tissue has been damaged and therefore the more severe the injury.

The Depth Of Burns Can Be Defined As:

- **Superficial** (1st Degree)
  This involves only the outer epidermis layer, and most commonly occurs from scalds or sunburn. The burn looks red, sore and swollen. If larger than 5% it is considered serious.
- **Partial Thickness** (2nd Degree)
  Affecting the epidermis and the dermis. The burn looks raw and blisters will form. A 9% burn will cause hypovolemic shock.
- **Full Thickness** (3rd Degree)
  All layers of skin are burned and the subcutaneous layer is affected. The burn may look pale, charred or waxy. The nerve endings may be burned away, so pain may be absent. A full thickness burn is **always** life threatening.

Location

The location of the burn can affect the severity; inhalation of hot gases is potentially life threatening, burns to the eyes may cause permanent blindness, burns to the chest may restrict chest expansion and burns to the limbs may cause limb tourniquetion.

Generic Presentation of a Burn:

- Airway involvement (discussed separately).
- Potential breathing difficulty (circumferential chest burn, airway involvement).
- Hypovolaemic shock (due to large blood plasma loss).
  - Tachycardia. Absence of radial pulse. Prolonged C.R.T.
- Cardiac Arrhythmias (due to plasma loss, tissue death, potassium release).
- Gradual reducing level of consciousness.
- Effects of toxic gas.
- Excessive pain.
- Tissue loss:

- Potential for infection.
- Adherence of clothing to skin.
- Heat loss if large TBSA affected.
- Potential circumferential limb injuries.

Management of Minor Burns (<5% Superficial / <0.5% Partial Thickness):

- Conduct primary / secondary survey.
- Assess burn (Size, Cause, Age, Location, Depth, Temperature):
  - TBSA burnt.
  - Is it an electrical or chemical burn?
- Cool the burn:
  - Cold running water for 15 minutes.
- Management wound.
  - Gently remove watches and jewellery, if possible.
  - A hydrating / cooling / antibacterial cream may be useful (Flamazine™).
  - Wrap the wound loosely with a non-adherent dressing.
- Management of pain.

Cool Burn

Flamazine™

Management of Major Burns:

- Do not put yourself in danger.
- Conduct primary / secondary survey & record observations.
- Assess burn (Size, Cause, Age, Location, Depth, Temperature). Be suspicious of airway burns.
- Contact medical support.
- Implement Compromised Airway Management.
- Implement Shock Management as appropriate.
- If large TBSA burn present, hypothermia is common.
- Give analgesia according to pain level & instructions of medic.
- Look for and treat any other injuries.
- Prepare to evacuate (as per vessel S.O.P's, the urgency of which can be assessed by the burn assessment.)

Non-Adherent Dressing

Wound Management.

- Remove watches, rings etc, as burned areas will swell.
- Clothing that has **not stuck** to the burn may be removed very carefully.
- Sterile antibacterial burns cream such as *Flamazine* may be applied as directed by Duty Medic.
- Dress the burn with a non-adherent dressing.
  - Cling film is one of the best dressings for a burn - discard the first two turns from the roll and apply it lengthways *(don't wrap it tightly around a limb).* Secure with a bandage.
- Alternative dressings could be; sterile plastic bag, low adherent dressings or specialized burns dressings.

NEVER burst blisters (it protects against infection)
NEVER apply lotions, ointments or fats - it might introduce infection.
NEVER use adhesive dressings
NEVER remove clothing that has stuck to the burn

Airway / Inhalation Injury (A.T.O.M.F.C.)

Inhalation injury is not a single entity. It consists of a variable combination of 3 factors:

Airway Burn

Caused by inhalation of hot gases (flame, smoke and steam). The injury is normally confined to the upper airway and leads to oedema with the risk of obstruction. The swelling develop instantly or slowly (2 and 36 hours).

Lung Injury

Occurs if the products of combustion are inhaled into the lower airway where they dissolve into the fluid lining the bronchial tree and alveoli. This leads to a *direct chemical lung injury,* which instigates an Acute Respiratory Distress Syndrome response, often delayed by hours or even days.

Airway Burns

Systemic Toxicity

Occurs from absorption of inhaled products of combustion. This is the most common cause of death due to fires in enclosed spaces. The most important agents are carbon monoxide and cyanides.

Airway swelling occurs progressively for many hours following inhalation injury and may not be evident when the casualty is first seen. It is important to anticipate those at risk of developing airway obstruction.

The Presence Of Any Of The Following Indicates The Possibility Of An Inhalation Injury:

- A history of exposure to fire or smoke in an enclosed space.
- Exposure to blast.

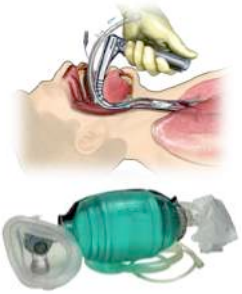
- Abnormal airway signs: **Singed nasal hairs / inflamed oropharynx / burns or sooting of face.**
- Abnormal airway sounds: **wheeze / stridor / hoarseness or any change in voice.**
- Breathing (RISE – FALL): **Rapid rate** / **visible chest injuries** (front & back) / **gross accessory muscle use** / **hyper-resonant** / abnormal breath sounds: **wheeze / harsh cough / soot in saliva.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).

Management of Airway Burns:

Time is critical, if an airway burn is found it should be treated as an emergency EVEN if the casualty appears relatively unaffected.

An asymptomatic casualty can become critical within a short space of time.

Airway Burns



- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management.
- In the presence of an airway burn endotracheal intubation is mandatory. (Remember that the swelling is likely to be increasing. In the majority of cases the patients will be conscious and endotracheal intubation will be impossible without first anaesthetising the patient.).
- Urgently contact medical support.
- Instigate shock management.
- Treat other burns in accordance with burns management.
- Prepare to evacuate (As per vessel S.O.P's).

Electrical Burns

Caused by heat that is generated by an electrical current flowing through the tissues of the body.

It is important to note that an electrical burn has an entry point and an exit point, and that all the tissue in-between has suffered damage. The extent of the internal burns can be estimated by the severity of the entry and exit wounds. An electric shock may cause cardiac arrest.

Management of Electrical Burns:

S.A.F.E. Approach

- Implement electric shock management.
- Implement burns management.
- Conduct primary / secondary survey & record observations. (Pay particular attention for irregular heart rate. This may indicate a cardiac arrhythmia).
- Assess Burn (Size, Cause, Age, Location, Depth / Time). Observe for an **entry** & **exit** point.
- Contact medical support.
- Wound management. (Irrigate the area of the burns, including the path between entry and exit, for at least 10 mins).
- Prepare to evacuate (as per vessel S.O.P's).

Chemical Burns

Chemicals may either corrode the skin or create heat *(though an exothermic reaction).* It is important to be aware any chemicals used in your workplace.

Management of Chemical Burns:

- Make the area safe - contain the chemical if possible and protect yourself from coming into contact with it.
- Take care to protect yourself wearing appropriate PPE (Personal Protective Equipment).
- Assess Burn (Size, Cause, Age, Location, Depth). Be suspicious of airway burns.
- Implement general burn management.
- Identify chemical & refer to its COSHH information.
  - Implement chemical specific treatment.
- Decontaminate affected area:
  - Dry powder chemicals can be carefully brushed off the skin before irrigating.
  - Irrigate the chemical burn with lots of running water (for at least 20 minutes).
  - Try not to wash the chemical onto unaffected areas of the body.
  - Ensure pools of contaminated water do not collect underneath the casualty.
  - Remove contaminated clothing carefully whilst irrigating the burn.
- If an eye is contaminated, irrigate as above, and ensure that the water runs away from the un-affected eye.

Work Place

BLAST INJURIES 8 (A.T.O.M.F.C.)

Exposure to an underwater blast will result in damage far in excess of that caused by a similar air blast. This is because water is an incompressible substance and transmits the pressure waves with the velocity of sound underwater. The surface, seabed or obstacles may also reflect the pressure wave. When the pressure wave hits the diver, it is transmitted through their body and will damage tissues adjacent to gas spaces.

With air explosions much of the pressure wave is reflected by the body surface, since it represents an interface between mediums of different densities. The density of the body and water are similar. Underwater the pressure wave passes through the body except at areas capable of compression, i.e. gas spaces.

Injury Type	Cause Of Injury	Organs Affected
Primary	Direct Impact On The Tissue Of Over-Pressure (Shock Wave)	Gas Filled Structures : Ears, Sinuses, Lungs, Git Tract
Secondary	Primary & Secondary Missiles Energised By The Blast	Head, Torso & Limb Penetrating & Non Penetrating Trauma. Damage To Solid Organs
Tertiary	Physical Displacement Of The Body By Blast Wind	Head and neck injury. Limb Fractures. Traumatic amputations. Damage to CNS, great vessels & solid organs.
Quarternary	Miscellaneous Noxious Effects Incidental To Blast Dust, Fires, Hot Gas.	Lungs, skin.

Therefore damage will be found at these interfaces:

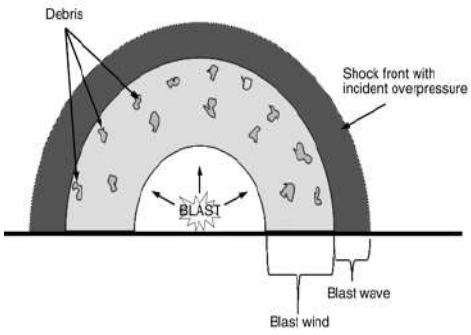
- Lungs.
- Sinuses.
- Ear cavities.
- The Gastro Intestinal Tract.

Presentation Of Blast Injuries

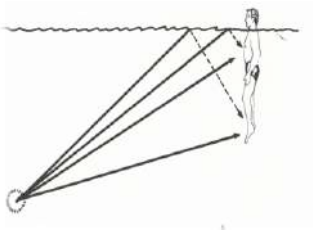
Primary Blast Injuries (Greatly enhanced underwater)

Dry suits could reduce the damage caused, since they would be the first water-air interface struck.

- Respiratory: Blast lung. Pulmonary contusions / thrombosis. A.G.E.
  - Acute respiratory failure.
  - Disseminated Intravascular Coagulation (DIC).
- Ears: Tympanic Membrane (TM) rupture, ossicle dislocation & disruption of oval or round window.
  - Hearing loss.
  - Tinnitus / vertigo.
  - Bleeding / discharge from external canal.
- Abdominal: Abdominal haemorrhage and perforation. Intestinal barotrauma more common with underwater air blast injuries.
  - Mesenteric ischaemia from gas embolism may cause delayed rupture of large or small intestine.
  - Abdominal pain, nausea, vomiting, heamatemesis.
  - Rectal pain / testicular pain.
  - Unexplained hypovolaemic shock.
- Cerebral: Traumatic brain injury (TBI). C.A.G.E. Stroke.
  - Concussion.
  - Headache, fatigue, poor concentration, lethargy, anxiety, and insomnia.
- Eye : (Globe rupture, retinitis, lid laceration, traumatic cataracts, injury to optic nerve).
  - Eye pain.
  - Foreign body sensation.
  - Blurred vision / decreased vision.
  - Drainage (Blood, straw coloured).



Pressure Exposure In Water



Secondary Blast Injury

- Penetrating ballistic or blunt injuries.
  - Penetrating foreign object in casualty's body.
  - Solid organ & bony injury.
  - Wounds can be grossly contaminated.

Secondary Blast Injuries

Tertiary Blast Injuries

- Due to persons being thrown into fixed objects by wave of explosions.
- Structural collapse may cause extensive blunt trauma.
- Rhabdomyolysis (Crush Injury Syndrome).
- Compartment syndrome.

Quaternary Blast Injuries

- Explosion related injuries or illnesses not due to primary, secondary, or tertiary injuries.
  - Drowning.

- Burns (chemical and thermal).
- Toxic inhalation.
- Radiation exposure.
- Asphyxiation (hypoxia, carbon monoxide and cyanide)

ANY DIVER who experiences an underwater blast is likely to have suffered some injury. No external injuries may show, but they may develop serious clinical symptoms and signs over the next couple of days, as a result of internal bleeding, etc. Therefore even in the absence of any physical injury a diver who has experienced a blast should be treated as an emergency.

Management of Blast Injuries:

- Conduct primary / secondary survey & record observations.
- Assess for potential primary, secondary, tertiary & quaternary injuries.
- Contact medical supoort. (*URGENTLY* stating 'blast injury').
- Treat specific injuries as discovered. (Be aware that pressurising casualty in a hyperbaric environment may delay potential surgery).
- Implement compromised airway / breathing management.
- Implement shock management as appropriate.
- Manage wound as discovered.
- Give analgesia according to pain level & instructions of medic.
- Prepare to evacuate. (As per vessel S.O.P's. A blast injury is ALWAYS an emergency).

CLIMATIC INJURIES 9

The body works best when its temperature is close to 37°C. This temperature is maintained by an area in the centre of the brain called the 'hypothalamus'. If the core temperature varies by just 2°C either way there will be an adverse biological reaction.

If the body becomes too hot we produce sweat, which evaporates and cools. The blood vessels near to the skin dilate *(flushed skin)* and the cooled blood is circulated around the body.

If the body becomes too cold we shiver, which creates heat by muscle movement. Blood vessels near to the skin constrict *(pale skin),* keeping the blood close to the warmer parts of the body. Hairs on the skin become erect, trapping warm air *(goose pimples).*

Injuries resulting from exposure to extremes of temperature can be 'localized': (*sunburn or frostbite),* or 'generalised' *(such as hypothermia or heat stroke).*

Hypothermia 9.1 (A.T.O.M.F.C.)

The onset of hypothermia occurs when the body's core temperature falls below 35°C. If the body's core temperature falls below 26°C the condition will most likely be fatal. However resuscitation has been successful on people with body temperatures as low as 10°C.

The underlying cause of hypothermia is over exposure to cold temperatures. However different conditions and types of patient will increase the risk.

These Include:

- The hypothalamus (temperature control centre) of a baby or young child is under developed, and hypothermia can result from as little as being in a cold room.
- Elderly or infirm patients do not generate as much body heat, so prolonged periods in a cold environment can lower the core temperature.
- Wet clothing, or immersion in cold-water results in the body cooling much faster than it would in dry air. Water conducts heat away from the body.
- A person who is not clothed properly in windy conditions will have cold air continually in contact with the skin, resulting in faster cooling of the body.

Presentation of Hypothermia:

- Cold, pale and dry skin.
- Uncontrollable shivering:
  - Shivering will stop when the core temp drops even further.
- Neurological impairment:
  - Slurred speech (may be mistaken for intoxication).
  - Tiredness, stumble, and falling.
  - Unexpected behaviour changes.
  - Disturbed vision.
  - Unconsciousness.
- Control centre disturbances:
  - Slow shallow breathing.
  - Slow weak pulse (the pulse can fall lower than 40 beats per minute).
  - Death.

Insulate Casualty

Management of Hypothermia:

- Conduct primary / secondary survey & record observations.
- Reassess regularly. (Use neuro exam including AVPU /GCS).
  - If conscious level is severely reduced (G.C.S. ≤ 8, Only responding to pain in AVPU).
  - Implement compromised airway / breathing management.
- Contact medical support. (*URGENTLY* if the core temp ≤ 35^{O}C).
- Warm casualty externally:
  - Remove any wet clothing and quickly replace with dry.
  - Place blankets or other insulating materials under and around the patient and cover the head (use a survival bag and shelter if casualty outside).
- Warm casualty Internally:
  - Give the casualty warm drinks and food.
- Implement Shock Management as appropriate.
- Implement unconsciousness management.
- Close monitoring should be maintained.
- Prepare to evacuate (as per vessel S.O.P's).
- If the casualty has 'died':
  - Resuscitation should be commenced.

NEVER give a patient alcohol (it dilates blood vessels, which will make the patient colder).

NEVER place direct sources of heat on or near the patient (they draw blood to the skin, causing a fall in blood pressure).

BEWARE: A hypothermic heart is in grave risk of 'ventricular fibrillation', which causes cardiac arrest.

BEWARE: If they appear dead. You MUST resuscitate. (The casualty must be warm & dead before they are certified).

- They should be resuscitated until their body temperature has reached above 35.5ºc.

Hypothermia and Diving

Commercial divers are at risk but because of the high conductivity of helium. There is a considerable respiratory heat loss associate with mixed gas use. It is mandatory to have a heated suit and, if he is below 150 metres, a heated gas supply. In a stranded bell the greatest risk to survival is hypothermia.

Many of the symptoms of hypothermia may not be apparent to the diver in the water and the supervisor should exercise special care. He should ensure that the diver returns to the surface or the bell immediately if his hot water supply fails. The diver himself will very quickly become unable to make a rational decision.

It is important to note that the hypothermic diver has two preservative mechanisms active; the higher partial pressure of oxygen will reduce cerebral hypoxia and the low temperature will instigate cryonic cerebral preservation. It is for these reasons that resuscitation should be maintained, even if the casualty appear beyond survival.

Cold Diver

Management of Hypothermic Diver:

- In a lost bell scenario, instigation of survival measures is a priority.
  - Remove wet gear / clothes.
  - Dry as best as possible.
  - Wear survival bag.
  - Use breathing apparatus to minimize respiratory heat loss.
  - Return to surface as soon as possible.
- His condition should be monitored closely and he should be given CPR if necessary.
- Instigate standard hypothermia therapy.

Frostbite 9.2

Frostbite is a condition caused when an extremity *(such as a finger or an ear)* is subject to cold conditions. The cells of the limb become frozen. Ice crystals form in the cells, which causes them to rupture and die. Frostbite may also be accompanied by hypothermia. Serious frostbite can result in the complete loss of a limb, particularly fingers or toes.

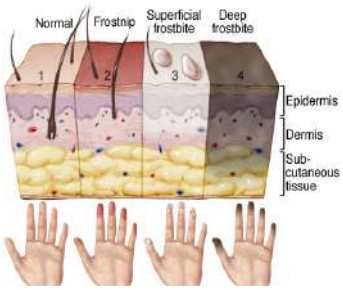
Trench Foot
This is caused by prolonged exposure to wet, cold conditions. The cells do not freeze, so full recovery is usual. The symptoms and treatment are similar to frostbite.

Chilblains
The most common cold injury, caused by exposure to dry cold. Again the cells do not freeze. There may be itching, reddish-blue skin and swelling. With time, blisters may form. Treat as frostbite.

Presentation of Frostbite:

- Cold to the touch.
- Altered skin sensation:
  - Prickly, tingling, burning or have reduced sensation.
- Altered skin colour / texture (dependant on degree of injury):
  - Hard, pale, white, blue.
- As the injury is warmed / re-perfused:
  - Skin may become red, swollen, blistered and painful.
- Gangrene can occur in advanced stages.

Stages of Frostbite



Management of Frostbite:

- Conduct primary / secondary survey & record observations.
- Contact medical support. (*URGENTLY* if the casualty has been unconscious or core temp ≤ 35ºC).
- Implement Hypothermia Management.
- Stop the freezing becoming worse if the casualty is still outdoors - place hands in their armpit or hold it with your hands.
- Move the patient indoors or in shelter.
- Gently remove rings, watches etc.
- Place the injury in warm water *(not with a frozen hand!).*
- Don't rub the injury - this will cause damage.
  - Don't re-warm the injury if there is a risk of it refreezing.
- Give analgesia for intense pain. (Aspirin for its anti-platelet effect & Ibuprofen for its anti-inflammatory effects.)
- Prepare to evacuate (As per vessel S.O.P's).

NEVER rub the affected area.
NEVER use direct or dry heat to warm the injury.
NEVER re-warm the injury if there is a danger of it refreezing

CAUTION:
To prevent frostbite always wrap the ice pack in a cloth and apply it for a maximum of 10 minutes. Allow the skin to return to normal temperature before repeat applications.

Heat Exhaustion 9.3

Heat exhaustion is the body's response to loss of water and salt through excessive sweating. The most common cause of this condition is working or exercising in hot conditions.

Heat exhaustion occurs when the core body temperature rises above 38°C. If it is not treated, it can quickly lead to heat stroke.

Presentation of Heat Exhaustion:

Heat Exhaustion

- Sweating profusely.
  - Pale and clammy skin.
- Headache, dizziness, extreme tiredness.
- Hypovolemic shock (due to excessive fluid loss).
  - Nausea & vomiting.
  - Cramps in legs or abdomen (due to salt loss).
  - Decreased urine output (urine is vey concentrated / dark).
  - Rapid pulse & respiration rate.
- Increasingly confused.

Management of Heat Exhaustion:

- Conduct primary / secondary survey & record observations.
- Reassess regularly. (Use neuro exam including AVPU /GCS) If the casualty's conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU).
  - Implement compromised airway / breathing management.
  - Contact medical support. (*URGENTLY* if the casualty has been unconscious or core temp ≥ 39°C).
- Cool the casualty:
  - Take the casualty to a cool, shaded area.
  - Remove excessive clothing and lay them down.
  - Use a fan (It is best used above the casualty to move air around them).
- Re-hydrate the casualty:
  - Oral rehydration solutions (*'Dioralyte') or* isotonic drinks are best as they also replace lost salt.
- Implement shock management as appropriate.
- Close monitoring should be maintained.
- Treat for heat stroke as necessary.
- Prepare to evacuate (as per vessel S.O.P's).

Heat Exhaustion Treatment

Heat Stroke 9.4 (A.T.O.M.F.C.)

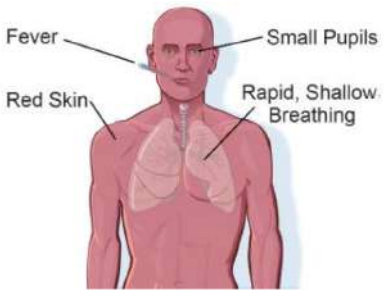
Heat stroke is a critical condition. It results from failure of the hypothalamus *(temperature control centre)* in the brain.

The sweating mechanism fails, the body is unable to cool down and the core temperature can reach dangerously high levels *(over 40°C)* within 10 to 15 minutes. Cellular death will occur at 44°c.

The condition can be caused by a high fever or prolonged exposure to heat and often follows heat exhaustion.

Presentation of Heat Stroke:

Heat Stroke



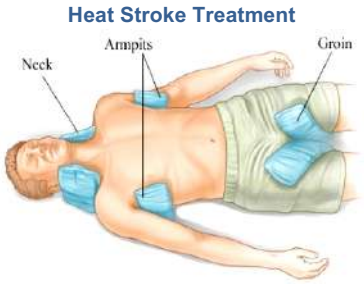
- Symptoms of Heat Exhaustion.
  - Fatigue, headache and irritability.
  - Nausea, vomiting and diarrhoea.
- Increased cerebral / hypothalamus temperature.
- Diminished sweating.
  - Hot flushed dry skin.
- Body temperature will raise above 40°c.
  - Strong bounding pulse & rapid respirations.
  - Neurological Impairment.
    - Disturbed or uncharacteristic behaviour.
    - Reduced conscious level.
- Death. (44°c).

Treat Heat Stroke as an **EMERGENCY**

Management of Heat Stroke:

- Conduct primary / secondary survey & record observations.
- Implement heat exhaustion management.
- Reassess regularly. (Use neuro exam including AVPU /GCS) If the casualty's conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU). Protect airway.
- Implement Compromised Airway Management.

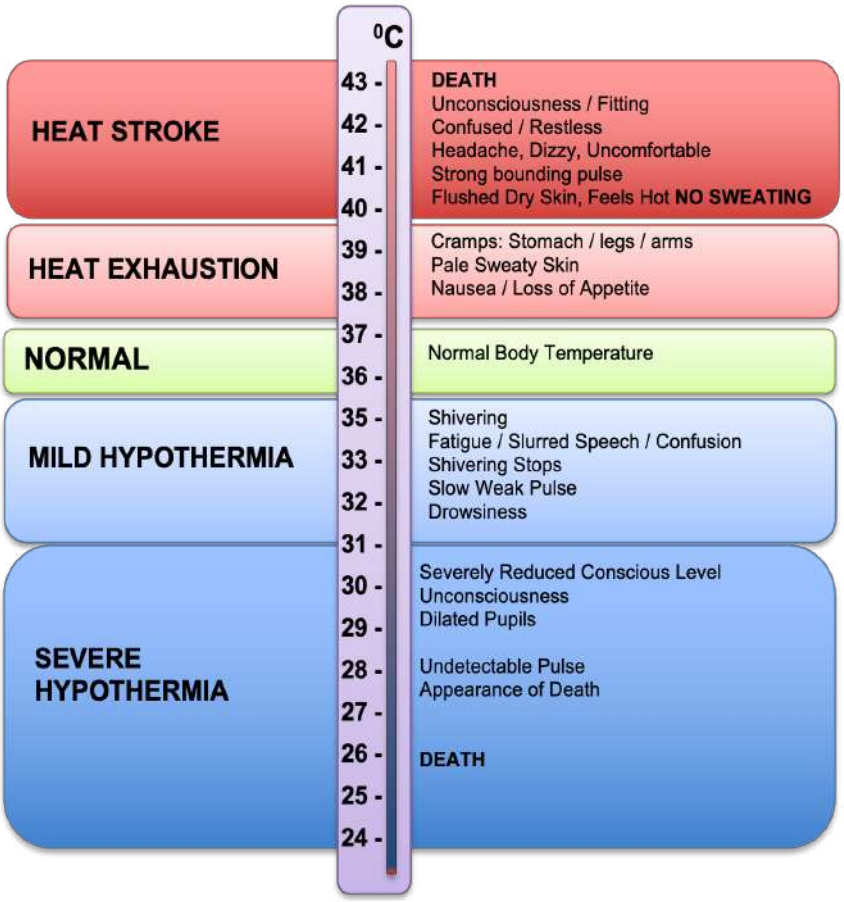
- **Urgently** Contact duty medic / supervisor.
- If the casualty has a seizure implement seizure management.
- Prepare to **URGENTLY** evacuate.



Methods of cooling:

- Remove outer clothing.
- Cool the casualty rapidly, using whatever methods you can:
  Wrapped ice packs over major arteries (carotid, femoral, axilla) is very effective.
- Continually sponging / spraying with cool water, and drying the casualty to speed evaporation.
- Implement Shock Management.
- *Keep cooling until temperature drops to 38°c.*

Presentation of Climatic Illness



DIABETES 10

Diabetes is a loss blood sugar (glucose) level balance, either because the body doesn't produce enough insulin, or because body cells don't properly respond to the insulin that is produced.

Insulin is a hormone produced in the pancreas, which enables body cells to absorb glucose, to turn into energy. If the body cells do not absorb the glucose, the glucose accumulates in the blood (hyperglycemia), leading to vascular, nerve, and other complications.

The normal blood sugar is between 4-6 mmols. However a blood sugar between 6-9 mmols is considered acceptable in diabetics.

There Are Many Types Of Diabetes, The Most Common Of Which Are:

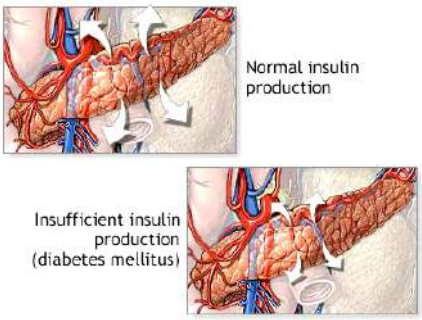
Type 1 Diabetes (Juvenile):

Which is a complete failure to produce insulin in the pancreas. Very often this presents in childhood. Almost exclusively the required treatment is injection of insulin several times per day.

Type 2 diabetes (Late Onset):

Which is either a partial failure to produce insulin in the pancreas or insulin resistance of cells. 'Overworking' of the pancreas & its insulin production can very often trigger this, common in extreme obesity and excessively fit individuals (athletes).

Diabetes



There Are Three Main Methods Of Treatment:

Diet

This patient still produces some insulin naturally, so can control the condition by reducing the amount of sugar that they eat. Tends to be Type 2 Diabetes.

Medication

The pancreas still produces a small amount of insulin naturally, and medication (Metformin, Glibenclimide) can be given to stimulate more insulin production. Tend to be Type 2 Diabetes.

Insulin

The pancreas produces little or no insulin, synthetically produces insulin will need to be injected 2 or more times a day in order to keep sugar levels under control. Tend to be Type 1 Diabetes or severe Type 2.

Low Blood Sugar (Hypo-glycemia)

Low blood sugar occurs mainly with diabetic patients who are insulin dependent, as the level of insulin in the body is now a 'fixed' amount because it is injected.

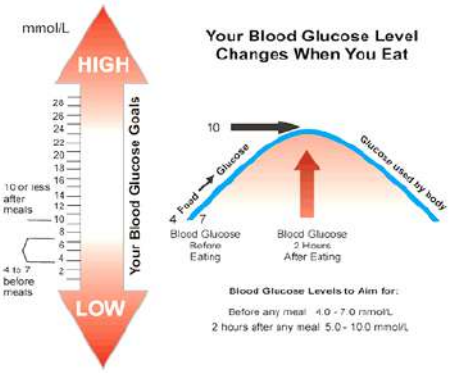
Because the patient has injected this 'fixed' amount of insulin, they have to balance the amount of food that they eat.

The Blood Sugar Levels Will Fall If:

- The patient does not eat enough food.
- The patient over exercises *(burning off sugar).*
- The patient injects too much insulin.

Unlike other cells in the body, the brain can only use glucose *(sugar)* as its source of energy. Therefore if the sugar in the blood becomes low, the brain cells are literally starved.

Normal Blood Sugars



High Blood Sugar (Hyper-glycemia)

Hyperglycaemia occurs if diabetes has not been treated effectively by the methods mentioned above.

The blood sugar levels increase as acids build up. The signs and symptoms are a result of the body trying to excrete this acid build up.

Hyperglycemia occurs during times of infection and inflammation when a diabetics metabolic system is raised. When the body is stressed, endogenous catecholamines are released that - amongst other things - serve to raise the blood glucose levels.

The Main Causes Of High Blood Sugars In Diabetics Are:

- Infective or inflammatory conditions.
- Exercising heavily.
- Taking an insufficient amount of insulin.
- Taking an excessive amount of carbohydrates.

Presentation of Low Blood Sugars (Blood Sugar <2.9mmols):

- Blood sugar low.
- Fast onset (2 - 60mins).
- Breathing: shallow & rapid.
- Rapid heart rate.
- Neurological impairment:
  - Weakness / Dizziness
  - Confusion
  - Bizarre Coordination (**Beware:** appear very similar to Alcohol Intoxication).
  - Unconsciousness within hr.
  - Permanent cerebral impairment.
- Pale, cold & sweaty.

Presentation of High Blood Sugars (Blood Sugar >15mmols):

- Blood sugar high.
- Slow onset (12-48hrs).
- Breathing: Deep sighing breaths
  - Fruity Odour on Breath.
- Rapid heart rate.
- Neurological impairment:
  - Drowsy / Lethargic
  - Eventual Unconsciousness leading to permanent cerebral impairment.
- Skin dry & warm.
- Excessive Urination (+ve to glucose & ketones on urinalysis).
- Profound Thirst
- Hunger

Management of Altered Blood Sugars:

For a conscious casualty:

- Conduct primary / secondary survey & record observations (Use full neuro exam including AVPU / GCS).
- Take a blood sugar reading. (as instructed by medical staff)
- Contact medical support. (*URGENTLY* if Blood Sugar ≤ 2mmol or ≥ 17mmols).
- Implement Shock Management as appropriate.
- If the blood sugar is ≤ 3mmols:
  - Give a sweet drink *(isotonic sports drinks are best)* glucose tablets or sweet foods.
  - If the casualty responds to treatment quickly, give them more food or drink.
  - Recheck blood sugar level. If it remains low give more carbohydrates.
- If the blood sugar is ≥ 17mmols.
  - Contact duty medic. Explain that the casualty has hyperglycaemia.
  - Give insulin as instructed by Duty Medic.
  - Recheck blood sugar level. Report back sugar levels to Duty Medic & follow instructions.
  - Look for and treat any of the causes of hyperglycemia (Infections; bacterial / fungal / viral).
  - Prepare to evacuate (as per vessel S.O.P's).
- Consider urethral catheterization.

For an casualty with a reduced level of consciousness:

- If the casualty conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU).
- Implement compromised airway / breathing management.
- Continue to observe & document the casualty's neurological state & blood sugar.
- If the blood sugar is ≥ 17mmols:
  - Give S/C insulin as directed by Duty Medic.
  - Recheck blood sugar level. Report back sugar levels to Duty Medic & follow instructions.
- If the blood sugar is ≤ 3 mmols:
  - Give Glucose (buccal absorbed glucose).
  - Continue to hydrate.
  - Recheck blood sugar level. Report back sugar levels to Duty Medic & follow instructions.
- Prepare to evacuate (as per vessel S.O.P's).

POISONING 11

Poison is anything that kills or injures through its chemical actions. Most poisons are swallowed (ingested). The word poison comes from the Latin word - potare - meaning to drink.

Poisons can enter the body in 4 ways, they can be:

Ingested
Swallowed, either accidentally or on purpose, this includes food poisoning.

Inhaled
Breathed in, accessing the blood stream very quickly as it passes through the alveoli.

Absorbed
Through the skin *(see chemical burns).*

Injected
Through the skin, directly into tissue or into a blood vessel.

Poisoning

A Poison Can Also Be Divided Into:

Corrosive
Such as: acids, bleach, ammonia, petrol, turpentine, dishwasher powder, etc.

Non-Corrosive
Such as: tablets, drugs, alcohol, plants, perfume etc.

Presentation of Poisoning:

The signs and symptoms of poisoning are wide, varied and dependent on the substance. Look for clues such as:
Smell on the breath. Containers or bottles. Tablets or drugs. Syringe or drug taking equipment.

Other Signs That Can Accompany Poisoning May Be:

- Vomiting or retching or diarrhoea.
- Pain (dependent on entry of toxin).
- Burns around the mouth and lips. Stains or odours on the person, clothing or area.
- Irregular pulse, raised temperature.
- Altered breath smells.
- Confusion or hallucination.
- Unconsciousness.
- Cyanosis.
- Breathing problems.
- Many conditions may be secondary to poisoning:
  - Seizures.
  - Drug / alcohol intoxication.
  - Symptoms of Shock.

Possible Poisons

Possible Treatment

Management of Poisoning:

For A Corrosive Substance:

- Don't endanger yourself - make sure it's safe to help. Apply P.P.E. as appropriate.
- Conduct primary / secondary survey & record observations (Use full neuro exam including AVPU / GCS).
- Contact duty medic / supervisor. (*URGENTLY*).
- Discover poisoning agent: refer to COSHH guidelines & follow.
- Implement compromised airway / breathing management.
- Implement shock management as appropriate.
- Implement anaphylaxis management.
- Dilute the substance or wash it away if possible:
  - Substances on the skin - see chemical burns.
  - Ingested substances - get the casualty to rinse out their mouth, and give frequent sips of water.
  - Oral carbon / charcoal is common (Mixed with water & given oraly or rectally)
- Follow instructions from duty medic.
- Prepare to evacuate (as per vessel S.O.P's).

NEVER make the patient vomit. This may put the airway in danger.

It helps if you :
- Pass on the containers or information about the substance.
- Find out how much has been taken & when.
- Keep a sample of any vomit for analysis.

For an casualty with a reduced level of consciousness:

- If conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU).
- Implement compromised airway / breathing management.
- Continue to observe & document the casualty's neurological state.
- Insert urethral catheter. Perform urinalysis (Observe for Glucose, Blood, Protein, Ketones & ↓Ph / ↑Ph).
- Prepare to evacuate (As per vessel S.O.P's..

Food Poisoning (Gastroenteritis) 11.1

Gastroenteritis is an inflammation of the gastric tract typically with diarroea & vomiting. Gastroenteritis can be due to infections by viruses, bacteria, parasites, and fungus. (The most common cause is Rotavirus / Norovirus, Bacterial cause include: Campyolobacter, E-coli, Salmonella, clostridium).

Generally highly contagious, spread via the oro-feacal route, but may also be spread in vomit (generally rotavirus spores, making it amazingly contagious).

Food may become contaminated with bacteria or viruses if it remains at room temperature for several hours, the bacteria multiply and increase the risk of infection in those who consume the food.

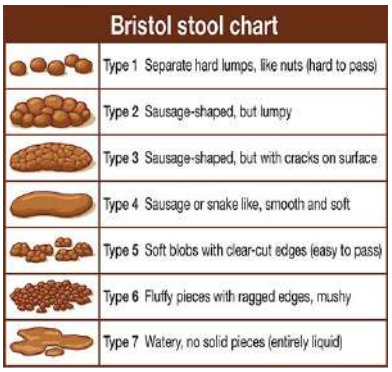
Foods commonly associated with gastroenteritis include raw or undercooked meat, poultry, seafood, and eggs, unpasteurized milk and soft cheeses; and fruit and vegetable juices.

It is estimated that three to five billion cases of gastroenteritis resulting in 1.4 million deaths occur globally each year.

Possible Symptoms

Presentation of Food Poisoning:

- Vomiting or retching.
- Diarrhoea. (This may seem infective & be grossly malodourous).
- Abdominal cramps / pain.
- Possible fever.
- Dehydration:
  - Low urine output.
  - Dry mouth.
  - Fatigue.
  - Headache and muscle pain



Management of Food Poisoning:

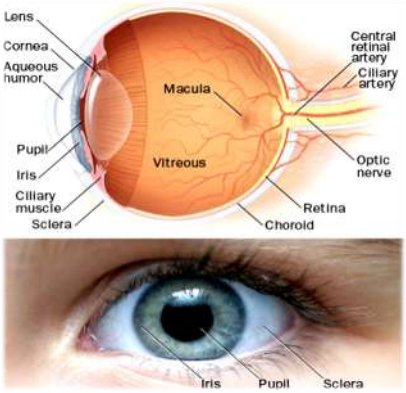
- Don't contaminate yourself - Apply P.P.E. as appropriate.
- Conduct primary / secondary survey & record observations & stool consistency (Using a Bristol Stool Chart).
- Contact medical support (highlight the possibility of an infectious condition).
- Isolate the affected:
  - If possible, ensure separate eating & toileting facilities.
  - Trace who has been in contact with & shared food with the victim.
  - Ensure captain aware of potential contagion event.
- Encourage hand washing:
  - Before & after toileting & eating.
  - Hot soapy water is better than alcohol gel.
- Hydrate casualty:
  - Address fluid & electrolyte loss.
- Try to find cause of poisoning:
  - Possibly isolate contaminated food / water source.
  - Collect a sample of faeces for c&s.
- Give medication as required:
  - Many gastroenteritis's are bacterial, so antibiotics are useful.
  - Anti-emetics are useful.
  - Beware of Anti-motility agents (such as Imodium) May induce mega-colon.

EYE DISORDERS 12

Eye injuries are irritating and painful, and some have the potential to be very serious. Even a superficial graze to the cornea can lead to scarring, resulting in permanent damage and deterioration in vision. Prompt first-aid treatment can be helpful.

Any injuries or infections of the eyes must be treated seriously. They should normally be referred to expert medical help. But if such professional help is not available, here are some simple steps that can be carried out to diagnose and treat common eye injuries and infections.

Eye Anatomy



Three Things Can Gauge The Seriousness Of An Eye Injury;

- The history of the injury.
- The amount of damage, which is immediately visible.
- The effect on vision.

Eye Abrasions 12.1

The front of the eye is extremely sensitive and abrasions can be very painful. If the cornea (clear part of the eye covering the iris) is injured it is prone to infection & gross inflammation.

Presentation of Eye Abrasions:

- Tears.
- Blurred vision.
- Increased sensitivity or redness round the eye.
- Pain.
- Continuous feeling that there is something in the eye.

Management of Eye Abrasions:

Eye Dressing

- Conduct primary / secondary survey (examine eye) & record observations.
- Instruct casualty NOT to rub eye.
- If there is something in the eye, irrigate the eye with clean water or sterile fluid from a sealed container, to remove anything loose from the eye.
- Contact medical support. Follow instructions from Duty Medic.
- Do not remove anything that will not be flushed out of the eye with water.
- Implement Wound Management. Secure a sterile dressing over the eye.
- Instruct casualty to minimise blinking.
- Prepare to evacuate (as per vessel S.O.P's).

Black Eyes 12.2

A black eye is bleeding beneath the skin around the eye. This can indicate a more extensive injury like a skull fracture, compression or brain injury, particularly if the area around both eyes is bruised or if there has been head trauma.

Presentation of Black Eyes:

Black Eye

- Bruising around eyelids and surrounding area.
- Swelling.
- Tender to the touch.
- Possibly blurring of vision.
- May feel dizzy.
- Eye may close up due to swelling.

Management of Black Eyes:

- Implement Eye Abrasion management.
- Steadily apply a small cold compress to reduce any pain and swelling of the eye area without putting any pressure onto the eye.
- Monitor eye for deterioration.
- Contact medical support. Follow instructions from Duty Medic.

Foreign Bodies 12.3

The problem begins suddenly - people often complain that 'something got into my eye.' There may be pain - especially on blinking - either because the surface layer on the front of the eye has been damaged or because it is still being damaged with each blink if a sharp foreign body is hidden under the eyelid. There is some watering.

There Are Three Places Where A Foreign Body May Have Lodged:

- It may be on the cornea.
- Under the eyelid.
- Inside the eye (a risk for the worker with high pressure gas).

Eye Examination:
To find the foreign body you need a good light and, ideally, a magnifying glass. First the cornea must be carefully examined. If no foreign body is found on the cornea, it is vital to check the inner surfaces of the upper and lower eyelids thoroughly. To do this properly it is necessary to turn the eyelid back - a skill known as 'everting'.

Presentation of Foreign Bodies:

- See Abrasions.
- Visible Foreign body.

Management of Foreign Bodies

- Implement Eye Abrasion management.
- If a foreign body is seen on the conjunctiva, irrigate the eye with sterile water.
- If irrigation fails, lift the foreign body off using a moist swab or the damp corner of a clean handkerchief or similar. Using a sterile eye bud is advocated.
- If it is suspected that there is a foreign body underneath the upper eyelid, ask the casualty to gently pinch their eyebrow and pull the upper eyelid over the lower eyelid. If this fails to dislodge the foreign body, blinking while irrigating may be successful.
- If a foreign body is deeply embedded, you could cause great damage. In this case patients **must** be referred to an *eye specialist*.

Removal of Foreign Body

Chemical Eye Injury 12.4

A chemical injury to the eye can cause permanent damage and blindness.

Eye Irrigation

Presentation of Chemical Injury:

- Severe burning pain in the eye.
- Redness and swelling around the eye.
- Inability to open the eye.
- Copious watering of the eye.

Management Chemical Injury:

- Implement Eye Abrasion management.
- The priority of the treatment is diluted and dispersed:
  - Use P.P.E. and Irrigate the affected eye for at least 10 minutes (you may need to prise the eyelids open).
  - Ensure the eyelid is thoroughly irrigated and avoid contamination of the unaffected eye.
  - Apply a sterile eye pad or a clean non-fluffy pad over the injured eye.
- Prepare to evacuate (as per vessel S.O.P's).
- If possible, identify the chemical involved to help medical staff prescribe the best possible treatment.
- Advise the casualty that movement of the injured eye, which could aggravate the injury.

Conjunctivitis 12.5 ("Pink Eye")

This is an acute inflammation of the conjunctiva (the outermost layer of the eye and the inner surface of the eyelids), most commonly due to an allergic reaction or an infection (usually viral, but sometimes bacterial).

Presentation of Conjunctivitis:

- Pain - from mild itching to severe pain.
- Yellow-green discharge (may even be pussy, causing eyelids to stick together on waking).
- Inflammation - of varying degree.
- Floaters over the eye.

Conjunctivitis

Management of Conjunctivitis:

- Implement eye abrasion management.
- Consult medical support.
- Take swab of eye & dispatch to Duty Medic.
- Apply antibiotic ointment – (normally chloramphenicol eye ointment - four times a day.)

EAR DISORDERS 13

Ear Infections 13.1 (Otitis Externa)

Exposure to water or humid atmospheres can produce maceration or softening and wasting of the skin of the ear canal. The canals itch or feel sore, and, if cleaned or scratched with implements like Q-tips, paper clips or pencils the macerated skin is further irritated and may become infected. Predominantly the infection is bacterial but occasionally fungal. The resulting infective condition is called otitis externa. Divers who are exposed to water with a high bacterial count, i.e. polluted water, are at special risk. Divers who have skin allergies or seborrhoeic dermatitis are particularly vulnerable and may develop otitis externa from showering or shampooing even when they are not diving or swimming.

Otitis Externa

Under normal conditions these bacteria are unable to survive in the ear because of the harmless bacteria already in residence. During saturation diving, the high humidity and the oxy-helium atmosphere kill the harmless bacteria and leave the field free for painful infections.

It is for this reason that prophylactic management is useful for the saturation diver:

Prevention of Otitis Externa:

- The preventative ear-drops are usually a silver acetate solution which makes the outer ear canal too acidic to support bacteria. When the solution dries it leaves a thin film across the surface of the skin, which further inhibits infection.
- The preventative drops should be taken on a regular basis as instructed (usually about every 8 hours) after diving and showering. One bottle must be provided for each ear to prevent cross infection.
- Swabs of the divers' ears are also taken on a regular basis and may be sent ashore or checked in a bacteriology laboratory on board the installation. The results will indicate the presence of unwanted bacteria before the diver experiences any symptoms and usually allow successful treatment in the chamber.

Presentation of Otitis Externa:

- Acute ear pain, often severe, accentuated by manipulation of the pinna or by pressure on the tragus.
- Itching and burning of the ear canal.
- Conductive hearing loss may result from oedema of the skin and tympanic membrane.
- Serous or purulent yellow-green discharge.
- Inflamed, swollen and tender external ear canal.
- The canal often is so tender and swollen that the entire ear canal and tympanic membrane cannot be adequately visualized (complete otoscopic examination may be delayed until the acute swelling subsides).
- The condition may progress to complete obstruction of the ear canal, abscess, and/or spread of infection into the surrounding tissues.

Antibiotic Ear Drops

Management of Otitis Externa:

- Conduct primary / secondary survey (including an examine ear) & record observations.
- Contact medical support. Follow instructions from Duty Medic.
- Cleanse the ear canal.
- Apply specific topical antibiotic therapy. (e.g., ofloxacin, gentamicin, ciprofloxacin), as directed.
- Analgesia management as indicated by pain. (Less severe cases can be managed by irrigating the auditory canal, using lukewarm tap water and carefully drying the canal after irrigation. After drying, a mild acid solution should be applied. This process should be repeated several times daily.)
- Swimming and diving should cease until symptoms have cleared completely.
- Prepare to evacuate if nil improvement (As per vessel S.O.P's).

Antibiotic Ear Drops

DENTAL DISORDERS 14

Avulsed Tooth 14.1

After a direct blow to the mouth the casualty may have a permanent tooth knocked from its socket. The tooth is intact, down to its root, from which hangs the delicate periodontal ligament that used to attach to alveolar bone and provide the tooth with its blood supply.

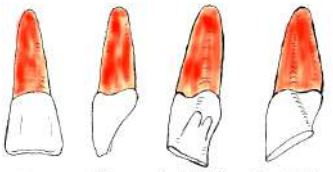
Presentation of Avulsed Tooth:

- The complete tooth is knocked out, root and all.

Avulsed Tooth

Management of Avulsed Tooth:

- Conduct primary / secondary survey (Examine mouth) & record observations.
- Contact medical support. Follow instructions from duty medic.
- Implement bleeding management (getting the casualty to bite on a sterile pack).
- Implement compromised airway / breathing management.
- The chance for successful re-implantation depends on first aid plus receiving dental care within a few hours.
  - Wash it gently with clean running water. Do not wipe the tooth or rub off any fibrous attachments.
  - Do not remove the blood clot from the tooth socket. Insert the tooth completely into the socket, lining up the biting edge with the adjacent teeth.
  - Splint the tooth in place with wax, thickness of metal foil or similar material, folding it into a "U" shape in front of and behind the tooth.
  - Mold well to surrounding teeth.
  - Press gauze or cotton around the gums if necessary for bleeding.
  - Drink liquids through a straw.



- If dental care is more than 2-3 hours away, successful re-implantation is unlikely. Dispose of the tooth, allow the socket to heal and a false tooth will be fitted later.
- Manage pain with appropriate analgesia.
- Monitor for signs of infection & give antibiotics as prescribed.
- Prepare evacuate to dental facility if nil improvement (As per vessel S.O.P's).

Implanted Tooth

Jaw Fracture 14.2

A fractured jaw is a break in the jaw bone. A dislocated jaw means the lower part of the jaw has moved out of its normal position at one or both joints where the jaw-bone connects to the skull (temporo-mandibular joints).

A broken or dislocated jaw usually heals completely after treatment. However, the jaw may become dislocated again in the future.

Presentation of a Fractured Jaw:

- Usually preceded by a blow to the jaw or chin.
- Difficulty speaking.
- Pain in the face or jaw, located in front of the ear on the affected side, which gets worse with movement.
- Sites of fracture are usually the side of the chin and near the ear.
- Casualty very often cannot match their teeth together normally.
- Presence of a haematoma under the tongue.
- The casualty may also hear or feel movement of the broken jaw.
- For a break near the ear, the jaw may move toward the broken side on opening.
- There may be tingling or numbness of the lower lip (lower jaw) or beside the nose (upper jaw).

Fractured Jaw

Management of a Fractured Jaw:

- Conduct primary / secondary survey (Examine Jaw) & record observations. (Observe closely for airway impairment. Airway management takes priority over jaw fractures)
- Contact medical support. Follow instructions from Duty Medic.
- Implement bleeding management as appropriate.
- Implement Compromised Airway Management.
- Implement Shock Management as appropriate.
- If there are missing teeth, a facial wound at the fracture site or exposed bone in the mouth, start antibiotic therapy as prescribed.
- If there are wounds in the mouth, brush the teeth if possible; use a clean brush, no toothpaste.
- Irrigate the wounds with salt water, and repeat several times daily if possible without disturbing the fracture.
- Apply Fracture immobilization.
  - Close the jaw, match the teeth as normally as possible, moving the jaw back into alignment if necessary.

- Pass several wraps of a bandage under the jaw and over the top of the head to splint the fracture.
- If there are severe facial injuries, be sure splinting the jaw dose not threaten the airway.
- Hold their head still with your hands. Keep the head and neck in line with the upper torso.

Fractured Jaw Management

- Implement wound management as appropriate.
- Give analgesia according to pain level & instructions of medic.
- Look for and treat any other injuries.
- Prepare to evacuate (as per vessel S.O.P's).

Dental Infections 14.3

Almost all dental infections are the result of poor hygiene. Thin layers of debris and bacteria build up under the edge of the gum (called plaque). In time, this hardens (calculus), irritating and inflaming the gum. Bacteria penetrate the damaged gum, causing local infection. If it becomes worse, infection invades the tissue supporting the tooth and even the jawbone itself.

Types of Dental Infection

Gingivitis

The most common form of gingivitis is in response to bacterial biofilms (also called plaque) adherent to tooth surfaces, termed *plaque-induced gingivitis*, and is the most common form of periodontal disease. In the absence of treatment, gingivitis may progress to periodontitis, which is a destructive form of periodontal disease.

Pyorrhoea

A more advanced infection with loss of gum tissue, supporting tissue and loosening of teeth.

Pericoronitis

Inflammation of gingival tissue around the crown of a partially erupted tooth. The lower molars are the usual site. Gingiva around the crown is red, swollen, and painful. It is seen almost exclusively in those teeth, which are partially erupted. Pericoronitis is caused by bacterial infection of the gingiva.

Presentation of a Dental Infections:

- Inflammation, redness and tenderness all over the gums.
- Bleeding. The teeth and gums of a person who has gingivitis become so sensitive that they start bleeding even while brushing or flossing.
- Discharge of pus.
- Toothache.
  - Severe, continuous pain.
  - Gnawing or throbbing pain.
  - Sharp or shooting pain.
- Pain when chewing.
- Sensitivity of the teeth to hot or cold.
- Bitter taste in the mouth.
- Breath odour. One of the main symptoms of gum infection, especially of peridontitis, is bad breath. You may have a foul mouth odour, which may not go away even after trying out different treatment methods.
- Possible fever.
- It is also common to experience mouth ulcers during gum infection.

Gingivitis

Management of Dental Infections:

- Conduct primary / secondary survey (Examine oral cavity) & record observations. (Observe closely for airway impairment. Airway management takes priority over jaw fractures)
- Contact medical support. Follow instructions from duty medic.
- Implement compromised airway management.
- Give analgesia according to pain level & instructions of medic. (Paracetamol & NSAID's are useful)
- Local heat pack can give some analgesic effect.
- Irrigate mouth with warm salt water (at least 3 times a day).
- Commence appropriate antibiotic therapy as prescribed & monitor effect.
- If a gum-boil appears, it can be lanced and drained with the tip of a hypodermic needle.
- Look for and treat any other injuries.
- Prepare to evacuate to dental facility if nil improvement (as per vessel S.O.P's).

INFECTION CONTROL 15

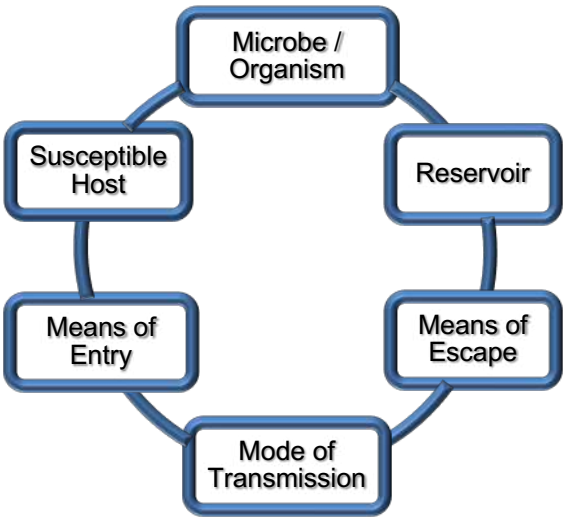
Infection control is concerned with preventing infection. It is an essential part of the infrastructure of health care.

Infection occurs when an organism enters the body and starts to grow. However, disease only occurs if the organism starts to multiply and produce symptoms. Our bodies have a great capacity to fight off organisms. Diseases result when these protective mechanism fail or are compromised.

The most dangerous organisms are those that are both very virulent and contagious. All organisms must enter the body in order to cause disease. The organism must stick or adhere to a specific cell, invade, colonize and inflict some type of damage to the host.

The 'spread' of infection is only possible if a certain number of elements are in existence. These elements form a link, which is commonly referred to as the 'Chain of Infection'. As with all chains, they are only as strong as the weakest link and if a single link is broken then infection CAN NOT occur.

The Chain Of Infection



There are six links in the chain of infection are:

- Causative Agent (Microbe / Organism).
- Reservoir
- Portal of Exit
- Mode of Transmission
- Portal of Entry
- Susceptible Host

Causative Agent (Microbe / Organism)
Infectious agents, which cause diseases include bacteria, viruses, parasites and fungi.

Reservoir

This is a place where organisms can thrive and multiply. This may be either inside the human body or outside. Some organisms may thrive in the human body, water, AC units, furniture or in a parasite such as a mosquito.

Portal of Exit
In order for an organism to survive and repeat the cycle of infection, it must have a way to exit the reservoir. For example, if the organism was growing in mouldy water in an air conditioning unit it may spread when the unit is switched on. In other cases, it may spread from humans through coughs, body fluids or faeces.

Mode of Transmission
Organisms may be transmitted by direct or indirect contact. Direct contact occurs when an individual comes into contact with the reservoir. Indirect contact occurs when the organism is able to withstand the harsh environment outside the host for long periods of time and still remain infective when the right opportunity arises.

Portal of Entry
Organisms need a point of entry. Some enter via the mucus membrane like the mouth, vagina or nose. Others enter via breaks in the skin (surgical incision or a laceration).

Susceptible Host
Most humans are not easily infected. Organisms usually cause infections in people who are weak, sick, and malnourished.

The main way of breaking 'The Chain Of Infection' is by instigating an aseptic approach. An Aseptic approach is the process by which we prevent microbial contamination during invasive procedures or care of breaches in the skins integrity.

There are two types of Asepsis: Medical Asepsis & Surgical Asepsis.

Medical Asepsis
Medical asepsis is concerned with eliminating the spread of microorganisms through simple preventative measures. The essential component of maintaining medical asepsis involves sterilization of organisms through:

- **Mechanical disinfection.** Physically removing potentially infected material. Scrubbing items clean, or

removing. Effective hand washing is an **excellent** mechanical disinfectant.

- **Chemical disinfection**. Using cleaning agents such as bleach, chlorine or ammonia. Alcohol hand gel is considered a chemical disinfectant.
- **Heat disinfection**. Boiling or heating to very high temperatures is a common sterilisation technique for surgical instruments.
- **Radiological disinfection**. Advanced processes such as gamma irradiation, also simple field techniques such as sun bleaching.

Surgical Asepsis

This is operating in 'the absence' of bacterial contamination. A classic example being an operating theatre. To maintain surgical asepsis a sterilized item will only come into contact with another sterile item.
In the management of pre-hospital wounds it is common to utilise a combination of both medical & surgical aseptic techniques.

Clean technique is a modified aseptic technique and aims to avoid wound contamination and prevent cross-infection.
Sterile materials are required, but the dressing technique can be greatly simplified.
The aim of dressing any wound, is to promote healing and prevent the transfer of organisms. Therefore, choice of a suitable dressing material is an important part of infection prevention and the healing process. To perform an effective 'Clean Technique' the first aider should always apply surgical gloves and utilize an aseptic no touch technique.

The 4 Principles of the ANTT
- Always wash hands effectively
- Never contaminate key parts
- Touch non key - parts with confidence
- Take appropriate infective precautions

Aseptic Non-Touch Technique

The Aseptic Non-Touch Technique (ANTT) means that when handling sterile equipment, only the part of the equipment **not** in contact with the susceptible site is handled. It is essential to ensure that hands, even though they have been washed, do not contaminate the sterile equipment or the patient.
The principle is that you **cannot** infect a key part if it is **not** touched. Any key part must only come into contact with other key parts, non-key parts should be touched with confidence.

Wound Management 15.1

- **Infection Control.** Wash your hands and put on disposable gloves. Apply Clean Technique.
- **Stop the bleeding.** Apply Bleeding Management. Hold the pressure continuously for at least 3 minutes and if possible elevate the wound. Don't keep checking to see if the bleeding has stopped because this may damage or dislodge the clot that's forming and cause bleeding to resume.
- **Assess the wound.** Identify what type of wound it is to establish a dressing choice. Assess what dressing is needed.
- **Clean the wound.** Utilize the ANTT. Rinse out the wound with sterilized saline or cleaning wipes. Clip hair close to the wound**.** Ensure the wound is dried with gauze. Soap can irritate the wound, so try to keep it out of the actual wound. If dirt or debris remains in the wound after washing, use tweezers cleaned with alcohol to remove the particles. Use soap to clean the area around the wound.
- **Dress the wound.** Utilize the ANTT and apply an appropriate dressing with confidence. Try and ensure any dressing is occlusive to avoid latter contamination.
- **Infection Control.** Dispose of all waste in a clean fashion. Wash your hands and dispose of gloves.
- **Action Plan.** Does the injury require medical intervention? Give the casualty advice on wound care. Review the wound every 24 hrs & maintain sterility. If the dressing gets wet, remove it immediately and apply a new one. After the wound has healed enough to make infection unlikely, exposure to the air will speed wound healing.

Seek medical advice if.

- You cannot control bleeding.
- There is a penetrating injury.
- If there is a puncture wound, particularly if foreign material in the wound is likely.
- You're unable to clean all the dirt from the wound.
- The cut is more than 1cm long, is on the face, appears deep, or has edges that separate.
- If there is nerve, tendon or vascular injury: Loss of sensation, numbness or movement. Loss of pulse, reduced CRT or colour.
- There are signs of Infection: Swelling, Heat. Pain, Pus or oozing, Red Streaks.
- They have not had a tetanus vaccination within 5 yrs.

- If you are unsure.

Wounds

An injury, especially one in which the skin or another external surface is torn, pierced, cut, or otherwise broken.

Types of Wounds

Contusion

A bruise. Caused by ruptured capillaries bleeding under the skin. This may have been the cause of a blunt blow, or by bleeding from undefined damage, such as a fracture.

Abrasion

A graze. The top layers of skin are scraped off, usually as the result of friction burn or sliding fall. Often containing particles of dirt, which cause infection.

Laceration

A rip or tear in the skin. More likely to have particles of dirt than a dean wound, although usually bleeds less.

Incision

A clean cut. Usually caused by a sharp object such as a knife. Deep wounds may involve complications such as severed tendons or blood vessels. This wound could 'gape open' and bleed profusely.

Puncture

A stabbing wound. Could be as a result of standing on a nail or stabbed. The wound could be very deep and yet appear very small diameter. Damage may be caused to underlying organs and severe internal bleeding may occur.

Ballistic Injury

Caused by a bullet or other missile, which may be travelling at such speed as to drive into and then exit the body. A small entry wound could accompanied by a large 'crater' exit wound. Severe bleeding and damaged organs usually results.

De-gloved

Severing of the skin from the body, resulting in 'creasing' or a flap of skin leaving a bare area of tissue. Caused by the force of the injuring item sliding along the length of the skin.

Chronic wounds

Caused by a relatively slow process that leads to tissue damage. Chronic wounds include pressure, venous, and diabetic ulcers.

Dressing Choice

Sterile dressings: these consist of a dressing pad attached to a bandage in sterile packaging. Various sizes are available.
Non-adhesive sterile dressings: some dressing pads are designed so that they do not stick to the damaged skin.
Adhesive sterile dressing pads. These consist of a dressing pad attached to an adhesive outer edge (essentially a large plaster). Various sizes are available.
Gauze pads: these can be used to clean around a wound. They can also be used for extra padding or absorption.
Skin closure tapes: these sticky strips are used to hold the edges of a cut together before applying a dressing.
Plasters. Plasters protect small cuts or grazes after they have been cleaned and dried.

Bandages.
Bandages are used to hold dressings in place, usually on limbs, or to help support a sprain.

Stretch bandage: for holding dressings in place. The skin around a cut may swell so the bandage must be able to stretch.
Crepe bandage: a soft, stretchy bandage that holds dressings in place. It also provides support and compression for a sprain.
Tubular bandage: this sleeve-like bandage supports sprained joints.
Triangular bandage: ideal as a 'sling' for a damaged arm.

DIVING MEDICINE 16

History Of Decompression Illness 16.1

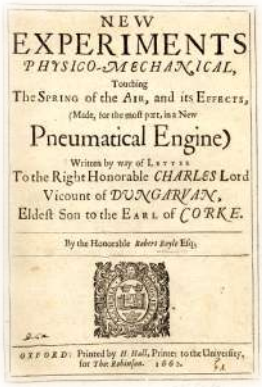
The "bends" is today readily associated with SCUBA diving. It is, in fact, an old-fashioned term used originally to describe the appearance of workers returning from 'caissons' during the construction of bridges in the 19th century. The air inside these underwater enclosures was pressurised to counteract the weight of the surrounding water. Following their shifts, some men would return to the surface suffering joint pain that made it difficult for them to stand straight. Their appearance was similar to the 'Grecian bend' adopted by fashionable women of the time - hence the name. Many workers died or suffered permanent disability because of "Caisson disease", as the condition became known.

Caisson Workers

The connection between the workers' return to the surface and their symptoms led to the introduction of surface based recompression chambers to treat the afflicted. However, the reason for the condition was not fully recognised until 1878, when Paul Bert published his theory that the cause was the formation of nitrogen bubbles within the body. He also correctly stated that it was possible to avoid their harmful affects by ascending to the surface gradually - and that hyperbaric chambers worked, in part, because they decreased the size of bubbles.

Bert noted the work of the scientist Robert Boyle. In 1667, Boyle observed that following exposure to a compressed atmosphere, and subsequent decompression, a bubble formed in the eye of a viper. The animal also appeared distressed by the experience.

As stated by Boyle's Law, ascending from a hyperbaric environment towards the surface results in an increase in the volume of a fixed amount of gas, including those found in the body. In the case of oxygen, the body quickly reabsorbs the extra volume as the cells use it up. Carbon dioxide, a waste product of metabolism, is excreted through the lungs very efficiently and therefore does not present a problem when decompressing.


NEW
EXPERIMENTS
PHYSICO-MECHANICAL,
Touching
The Spring of the Air, and its Effects,
(Made, for the most part, in a New
Pneumatical Engine)
Written by way of Letter
To the Right Honorable CHARLES Lord
Vicount of DUNGARVAN,
Eldest Son to the Earl of CORKE.
By the Honorable Robert Boyle Esq.
OXFORD: Printed by H. Hall, Printer to the University,
for Tho. Robinson. 1662.

The body does not use nitrogen, however, which forms almost 79% of the air. For the purposes of discussing decompression, it is an 'inert' gas, as is helium. Unless enough time is allowed for the inert gas to be excreted through the lungs, any collection within the body's tissues can increase in volume to the point where bubbles are formed.

These can lead to the formation of emboli (singular: embolus) that cause adverse physiological effects by impeding blood flow and/or damaging tissues or nerves. It should be noted that the presence of inert gas bubbles does not in itself lead to problems - what is important is the eventual size of these bubbles, their location, and the ability (or inability) of the body to rid itself of them before they cause damage.

The first recorded chamber was built and run by a British clergyman named Henshaw. He built a structure called the *domicilium* that was used to treat a multitude of diseases. The chamber was pressurized with air using bellows.

Steel Ball Hospital

The French surgeon Fontaine, who built a pressurized, mobile operating room in 1879, continued the idea of treating patients under increased pressure.

Dr. Orville Cunningham, a professor of anaesthesia, ran what was known as the "Steel Ball Hospital." The structure, erected in 1928, was 6 stories high and 64 feet in diameter. The hospital could reach 3 atmospheres of pressure. The hospital was closed in 1930 because of the apparent lack of scientific evidence indicating that such treatment alleviated disease. It was deconstructed during World War II for scrap to aid the war effort.

DYSBARISM 16.2 (The Diseases of Diving)

Dysbarism refers to medical conditions resulting from changes in ambient pressure. Various activities are associated with pressure changes. Diving is the most common, but pressure changes also affect people who work in other pressurized environments (caisson workers), and people who move between different altitudes.
Within diving the term dysbarism can be used to describe a host of diving conditions.

These Include;

- Barotraumas.
- Arterial Gas Embolisms (A.G.E.)
- Decompression Sickness.

Acute Decompression Illness 16.2.1

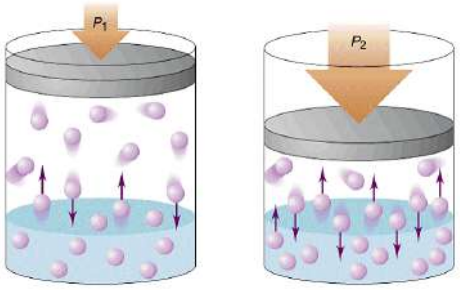
Decompression Illness (DCI) is a term that has been used for over 50 years. DCI includes both A.G.E.'s and Decompression Sickness.

Acute decompression illness (DCI) is a syndrome of numerous possible manifestations, which may develop following decompression. It is thought to be initiated by bubbles of inert gas in the body tissues and blood stream. Although the means where, by these bubbles cause tissue dysfunction have yet to be fully understood, the manifestations have been recognised for many years and are described below.

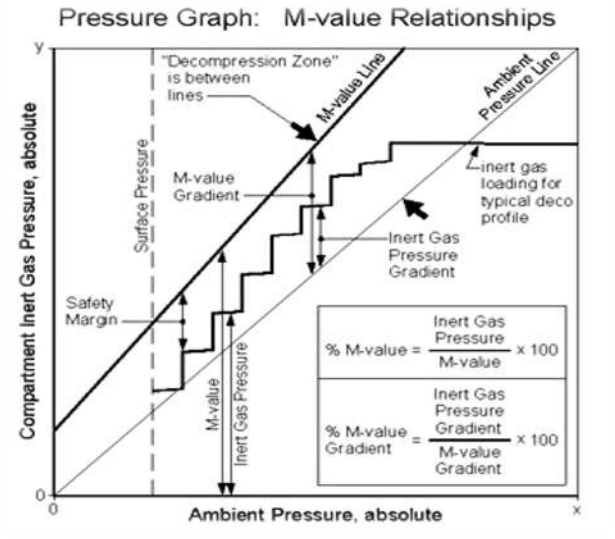
Disease Mechanisms

There Are A Number Of Sources Of These Gas Bubbles:

The partial pressure of inert gas in arterial blood is approximately the same as the partial pressure in the gas mixture, which is being breathed. For example, at sea level, both air and arterial blood contain approximately 0.79 bar of nitrogen. During most dives or hyperbaric exposures, the partial pressure of the inert gas being breathed increases with depth and the concentration of that gas in arterial blood increases accordingly. For example the partial pressure of nitrogen in air at 2 bar is approximately 1.58; when this is breathed the partial pressure of nitrogen in the arterial blood is also approximately 1.58 bar. This effect is the same with different mixes and inert gases such as helium. Under these circumstances, the partial pressure of inert gas in tissues will gradually increase due to blood/tissue gas transfer until it equals the ambient partial pressure. In this state the tissues are considered to be saturated.



During decompression, inert gas moves in the opposite direction, from the tissues into the blood, where it is carried to the alveoli in the lungs and exhaled. If this process occurs in a controlled manner, so that the inert gas tension in the tissues does not reach a sufficient level of super saturation (exceeding M values) then bubbles of gas will not form and the decompression will progress uneventfully. However, if the rate of decompression is such that the capacity of the tissues, cardiovascular system and lungs to remove inert gas is exceeded, bubbles of that gas may start to form in tissues or blood.



Bubbles in venous blood, for example, are efficiently removed from the circulation by the lungs and numerous studies have demonstrated the presence of such bubbles in asymptomatic divers. Furthermore, bubbles may form in some tissues (such as adipose tissue) without causing overt disease. However, other tissues, particularly nervous tissue, are much more sensitive and the presence of even a small number of gas bubbles may result in abnormal tissue function.

Arterial gas bubbles. The lungs are excellent filters of gas bubbles. However, this capacity is finite; if the bubble burden is such that this is exceeded, they will transit the lungs and enter the arterial circulation. This can occur after heavy gas tissue loading and a rapid decompression.

The transit of venous bubbles to arterial blood may occur before the pulmonary filter is overwhelmed. In approximately 25-30% of the normal, adult population, the septum that separates the upper chambers of the heart contains a potential or actual defect, which is known as a Patent Foramen Ovale or PFO (This is a relic of the foetal circulation and normally results in no ill effects). However, it does offer a possible route for bubbles to bypass the pulmonary filter and consequently, along with other right-to-left shunts, has the potential to promote the arterialization of otherwise relatively harmless venous bubbles.

Bubbles in arterial blood physically obstruct small blood vessels and thereby cause tissue ischaemia (oxygen starvation through reduced blood flow).

This Localised Ischaemia Create A Cascade Reaction Which;

- Initiates local tissue inflammatory reaction.
- Increases localised tissue ischaemia.
- Increased endothelial permeability + leakage of plasma.
- Increased local pressure.
- Resulting in further inflammatory reaction & activation of the immunological complement.

Although it is recognised that tissue bubbles may arise from two fundamentally different processes it is often difficult, in individual cases, to be certain of the origins of the disease-provoking gas. Indeed, with respect to some organ systems, such as the ear and lungs, it may occasionally be difficult to distinguish between a bubble-induced condition and the results of barotrauma.

Consequently, it is now recognised that, for practical purposes, the distinction between the conditions that used to be known as decompression sickness and arterial gas embolism was artificial. As a result, the term decompression illness, which encompasses the two, is increasingly being used to reflect this.

Manifestation of D.C.I. 16.2.2

DCI is a multi-system disease with single organ involvement is uncommon.
The effects of the gas bubble load tends to attack the densest of tissue (or the slowest compartments), these are the nervous system, tendons / synovial joints, lymphatic tissue and adipose (fat).
DCI may present with a bewildering array of symptoms, which can lead the clinician to suspect what the underlying system effected is.

DCI type	Bubble location	Signs & symptoms (clinical manifestations)
Neurologic	Brain	• Altered sensation, tingling or numbness paresthesia, increased sensitivity hyperesthesia. • Confusion or memory loss. • Visual abnormalities (Including NYGAGMUS). • Unexplained mood or behaviour changes. • Seizures, unconsciousness.
Neurologic	Spinal cord	▪ Ascending weakness or paralysis in the legs. ▪ Girdling abdominal or chest pain. ▪ Urinary incontinence and fecal incontinence.
Audio-vestibular (Neurologic)	Inner ear	▪ Loss of balance. ▪ Dizziness, vertigo, nausea, vomiting. ▪ Hearing loss.
Constitutional (Probable Neurologic)	Whole body	▪ Headache. ▪ Unexplained fatigue. ▪ Generalised malaise, poorly localised aches.
Musculoskeletal	Mostly large joints (elbows, shoulders, hip, wrists, knees, ankles)	Localized deep pain, ranging from mild to excruciating. Sometimes a dull ache. Active and passive motion of the joint aggravates the pain. ▪ The pain may be reduced by bending the joint to find a more comfortable position.
Pulmonary	Lungs	▪ Dry persistent cough. / Shortness of breath. ▪ Burning chest pain under the sternum, aggravated by breathing.
Cutaneous	Skin	• Itching, usually around the ears, face, neck, arms, and upper torso. • Sensation of tiny insects crawling over the skin. • Mottled or marbled skin usually around the shoulders, chest and abdomen, with itching. • Swelling of the skin, accompanied by tiny scar-like skin depressions (pitting odeama).
Lymphatic	Lymphatic Vessel	▪ Localised tissue swelling / oedema. ▪ Possibly due to blockage of the lymphatic vessels draining a specific group of lymph nodes (usually in trunk, head or neck).

Traditional Classification Of DCI 16.2.3

As discussed, DCI as a disease / syndrome has been in existence for over 150 years. It is not surprising then that the disease has had many names and tools to describe its effects.

In addition to the "bends", the effects of "Caisson disease" have several other descriptive terms, the "chokes", "staggers" and "niggles".
From the 1950's the label 'decompression sickness' (DCS) was introduced in place of "Caisson disease".

Decompression Sickness Was Divided Into Three Subsections:

- Arterial Gas Embolisms.
- Type 1.
- Type 2.

The different classification reflects the effect, and therefore the severity, of the condition. Diagnosing DCS as one (or both) of just two categories does not enable proper identification or discrimination.
Arterial Gas Embolisms are discussed later in Barotraumas. However, the two types are described here.

Type 1 D.C.I.

Type 1 DCS can occur when bubbles affect the tissues around skeletal joints. Decompression sickness might also present as a skin (cutaneous).

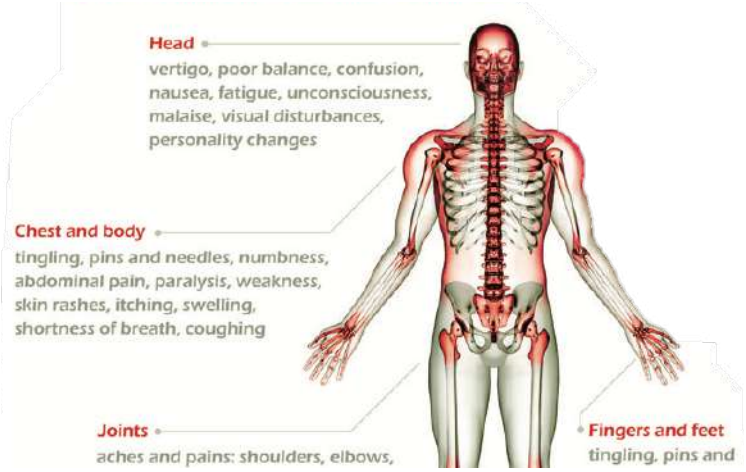
- Local pain, usually in joints of arms or legs (knees, elbows and shoulders).
- Pain made worse by exercise.
- Itching, blotchy skin rash, mottling, raised section of the skin.

Type 2 D.C.I.

Type 2 Decompression Sickness reflects involvement of the Central Nervous System (CNS) and / or the cardio-respiratory system.
More than half of those diagnosed with DCS will be classified as Type 2. Cerebral symptoms arise from interruption of the blood supply to the main part of the brain, and include confusion, reduced mental function and unconsciousness.
Involvement of the cerebellum may lead to tremors, loss of balance ("staggers") and a lack of co-ordination (ataxia). Balance may also be affected by damage to the vestibular part of the inner ear.

Symptoms Include:

- Dizziness.
- Ringing in ears.
- Difficulty in seeing.
- Shortness of breath.
- Rapid breathing.
- Choking.
- Severe pain.
- Pain in abdomen.
- Extreme fatigue.
- Loss of sensation (numbness).
- Weakness of extremities.
- Staggering.
- Paralysis.
- Collapse or unconsciousness.



The advantages of using the 'classical' classification system are overall familiarity, for over 50 years it has been the accepted description of the manifestation of DCI.

However there are multiple disadvantages in the use of this classification system; precise mechanistic diagnosis is often impossible due to the fact that DCI frequently have multiple manifestations.

It is common for multiple physicians to describe a condition as both Type 1 & Type 2 leading to a wide variations in diagnosis and ultimate treatment.

Modern Terminology Of DCI 16.2.4

Since the late 1990's a much more modern, descriptive-manifestation system of classifying DCI was introduced (At a 1991 Undersea and Hyperbaric Medical Society workshop).

Since decompression illness can interfere with the function of a wide range of body tissues, the number of potential signs and symptoms is truly enormous. Rather than using a somewhat artificial classification on the decompression disorders (types I and II), a better understanding of DCI is likely to result if a descriptive system is used.

This System Is Split Into Three Components:

- Time of **onset** of symptoms.
- The **evolution** of symptoms.
- The actual **symptoms**.

Onset

The time of symptom onset is a key factor in the diagnosis of DCI 98% of all DCI's will present within exit from the water. The term "acute" is used to distinguish these conditions from possible "chronic" consequences of diving such as dysbaric osteonecrosis.

- **Acute.** The condition has manifested recently.
- **Chronic.** The condition has manifested some time ago..

Evolution

The evolution term is used to describe the development of the condition PRIOR TO RECOMPRESSION. DCI is frequently a rapidly changing condition.

The Evolution Of The Symptoms May Be Described As:

- **Progressive.** A progressive condition would be if the number or severity of symptoms or signs is increasing.
  - Increasing severity of limb pain and the involvement of additional joints.
  - A neurological presentation in which the loss of motor or sensory function is becoming more profound.
  - The development of a new manifestation.
  - Terms such as "rapidly" or "slowly" may be used to enhance the description of this evolution.
- **Static.** This is self-explanatory. Neither the severity nor number of manifestations is changing substantially.
- **Spontaneously Improving.** DCI that improves, without recompression.
  - Cutaneous skin bends. (Substantial improvement must occur for this term to be applied).
  - As with other evolution terms, "improving" should only be used to describe events prior to recompression.
- **Relapsing.** Occasionally, cases that have improved spontaneously undergo a secondary deterioration.
  - Common with neurological manifestations.
  - When a condition gets worse in the absence of spontaneous improvement it is described as "progressive".
  - "Relapsing" should be reserved for cases, which have, at some stage in their evolution, undergone substantial and spontaneous improvement.

Symptom Manifestations

There are a number of manifestations of decompression illness, which occur commonly, and these are outlined below. They may occur alone or in combination.

- **Limb Pain**. One the most frequent manifestation of DCI (second to lethargy / fatigue).
  - Deep aching pain in or around one or more joints.
  - Following 'bounce' dives, the upper limbs and the shoulder is involved particularly frequently.
  - Conversely, in saturation divers, it is the lower limbs and the knees, which are involved most commonly.
  - The pain is usually poorly localised; it may resolve spontaneously and is then known as a ‘niggle'. Niggles may flit from joint to joint.
  - If the pain gets worse, it becomes more readily localised and is described as a dull, boring ache, similar in character to tooth ache. Sometimes the joint is held in a particular position that is least painful, but pain is seldom made worse by movement.
  - If the pain is in a lower limb, weight bearing may be poorly tolerated on that limb.
  - The 'classical' signs of inflammation: redness, swelling, warmth to the touch and tenderness are **missing.**
- **Girdle Pain**. This is a poorly localised, aching or 'constricting' sensation, generally in the abdomen or pelvis.
  - Girdle pain is generally considered ominous since it frequently portends neurological deterioration.
- **Neurological.** Involvement of the nervous system may be subtle and multi-focal. Consequently symptoms can be of bewildering variety and very difficult to localise. Both the central and peripheral nervous systems may be involved and the manifestations can be broken down into the loss of certain functions:
  - Aberration of thought processes, loss of memory, speech disorders, alteration to the level of consciousness including seizures; loss of co-ordination; loss of strength or sensation.
  - Dysfunction of special senses and loss of sphincter control, especially of the bladder.
  - Loss of consciousness to the point of disorientation is a frequent finding and coma may occasionally ensue.
  - Motor and other sensory deficits.
  - Signs such as a change of mood, dulling of intellect and loss of short-term memory.
- **Neurological (Spinal).** Spinal cord is involved in neurological DCI with some frequency. It may appear to be involved alone or with other parts of the nervous system.
  - Short, deep dives with a rapid ascent to the surface are commonly involved.
  - The onset of symptoms commonly occurs shortly after dive (about half of cases are symptomatic within 10 minutes).
  - Less than 10% of serious cases present more than 4 hours after completing the dive.
  - In severe cases, the condition is often heralded by the onset of girdle pain.
  - Shortly afterwards, the patient may notice pins and needles, numbness and muscular weakness in the legs.
  - Which may rapidly progresses to paraplegia.
  - Neurogenic (spinal) shock may complicate the clinical picture.
  - The bladder is frequently involved (difficulty to void or full retention).
- **Audio-Vestibular (Neurological).** This is a unique subclass of neurological decompression illness. It is thought that there are two mechanisms whereby the audio-vestibular system may be involved: barotrauma (perilymph fistula / oval round window rupture) and tissue injury resulting from the formation of bubbles from dissolved gas.
  - Targets of these micro-bubbles include; the cochlea, the eighth nerve nuclei and cortical pathways.
  - It is very difficult to distinguish between these mechanisms or sites of injury by clinical examination alone.
  - The syndrome includes: vertigo (a sense of rotation), tinnitus, nystagmus or loss of hearing after a dive.
  - Nausea and vomiting may accompany these symptoms.
  - Previously there has been hesitation before prescribing recompression in such cases for fear of further tissue damage.
  - Recompression does not have an adverse effect on pathology due to round or oval window rupture.
- **Pulmonary. (The Chokes)** Related to the lungs: decompression pulmonary barotrauma and the cardiopulmonary consequences of massive venous gas embolism.
  - The mechanisms are distinctly different; it may be difficult to distinguish between them immediately in a clinical setting, because many of the symptoms and some of the signs are shared.
  - Those which imply pulmonary (or, rarely, cardiac) involvement in decompression illness are: chest pain, cough, haemoptysis, shortness of breath, cyanosis and, rarely, cardiogenic shock.
  - Progressive disease (where the symptoms are worsening) may be due either to a tension pneumothorax or massive gas embolism of the lungs.
  - Where there has been a dive, which has induced a low gas burden, it is most likely that a pneumothorax. This may be diagnosed clinically from the classic signs (described in the Gas Embolism section).
- **Cutaneous.** The skin may be affected in two manifestations of decompression:
  - Cutaneous DCI generally presents with severe itching around the shoulders or over the trunk.
  - This develops into an erythematous rash, which may progress to cyanotic mottling or marbling of the skin.
- **Lymphatic.**
  - Lymph nodes may become enlarged and tender and this may be associated with oedema.
  - The skin feels thickened and may have the ‘pitted' appearance of orange peel.

- If pressure is applied to the skin for about a minute or so, a visible indentation remains.

- **Constitutional.** There are a number of non-specific symptoms that occur after diving and which, if severe or accompanied by other manifestations, may be considered part of the decompression illness syndrome.
  - Symptoms include headache, fatigue, malaise (may include nausea and vomiting) and anorexia (loss of appetite)

Applying The Terminology

By including the onset, evolution and manifestation terms in the phrase "decompression illness", a highly flexible diagnostic label can be applied to any case. This label imparts a great deal of information and because it does not require the observer to guess at either a mechanism of the disease or location of the lesion, it should be possible for these terms to be applied consistently.

This is an important tool because the diagnosis of DCI is overall a clinical one (there is no diagnostic blood test or xray).

The disadvantage of this system is that it is generally verbose and it marginally ignores pathophysiology (rather than distinguish between musculo-skeletal and neurological pain, it simply uses 'limb pain').

The advantages of this system are; an improved data collection with regards to manifestations of DCI, No real need for precise mechanistic diagnosis, a uniformity of reporting cases of DCI and once a clinician is use to the system it is relatively easy to use.

Examples Of How The Terminology Is Used Include:

Acute , Relapsing, Neurological, DCI

or:

Acute, Progressive, Limb Pain And Cutaneous DCI

In rare, highly complex cases, rather than enumerate a long list of manifestations, it may be appropriate to use the term 'multi-system'.

Example Diver

25 year old male, diving on air.

- 2 dives:
  - 32 metres for 45 minutes total dive time.
  - 2 hour surface interval.
  - 32 metres for 35 minutes total dive time.

Worsening pain in left shoulder, with associated tingling in left hand, 30 mins after surfacing from 2nd dive.

Description:

Acute Progressive Neurological and Limb Pain DCI.

Additional DCI Factors 16.2.5

While the descriptive diagnostic terminology imparts a considerable amount of information, it is inadequate, of itself, to summarise a case of decompression illness. DCI is a poorly understood syndrome and if a better understanding is to evolve, it is important that additional information is collected:

The Time Of Symptom Onset

% Cases	First Symptoms
42%	Within 1 Hour
60%	Within 3 Hours
83%	Within 8 Hours
98%	Within 24 Hours
100%	Within 48 Hours

DCI usually presents within a 24hr period following a dive although rarely it can present outside of this. Symptoms may become apparent before surfacing in saturation and occasionally in bounce dives, particularly where decompression has been omitted.

Most symptoms occur after surfacing and the majority of serious neurological or pulmonary symptoms are usually manifest within about 30 minutes.

The onset of limb pain also occurs in this time period but this may be delayed for many hours after a dive. It should be remembered that decompression illness might be provoked or made worse many hours after a dive if the diver takes a flight. If a diver has been asymptomatic for 48 or more hours after a dive and has not flown, then symptoms, which develop subsequently, are probably not DCI.

The time of onset of symptoms influences prognosis, a short latency implies severe disease (e.g A.G.E. / C.A.G.E.), late severe symptoms indicates a secondary pathology (such as haemorrhage).

An exceptionally delayed DCI should not be completely discounted due to the possibility of 'diver denial', this is a basic reluctance of an individual diver to admit that they have relevant symptoms.

Gas Burden

When considering possible mechanisms for DCI, it is desirable to estimate the amount of gas that is likely to be present in the various tissues. Consequently it is important that the dive profile is recorded as accurately as possible with the inclusion of the gas mix breathed. Where a dive computer or depth-time recorder was worn, the information should be retrieved from this source.

Presence of Risk Factors

It is important to evaluate the possible risk factors associated with the dive, these risk factors include;

- Dive profiles (Sawtooth pattern / shallow to deep dives / rapid ascent / multiple daily dives / omitted decompression / new dive / exercise at depth / during or after decompression).
- Individual diver (Age-fitness-weight of diver / dehydration / Patent foramen ovale (PFO) / Limb tourniquetion).
- Temperature (High temperatures lead to dehydration > blood plasma loss > reduced venous off-gassing. Low temperatures cause vasoconstriction & reduced off-gassing, particularly in adipose tissue).
- Altitude exposure. (This does not have to be flying alone; a mountain ascent is an equal risk factor).

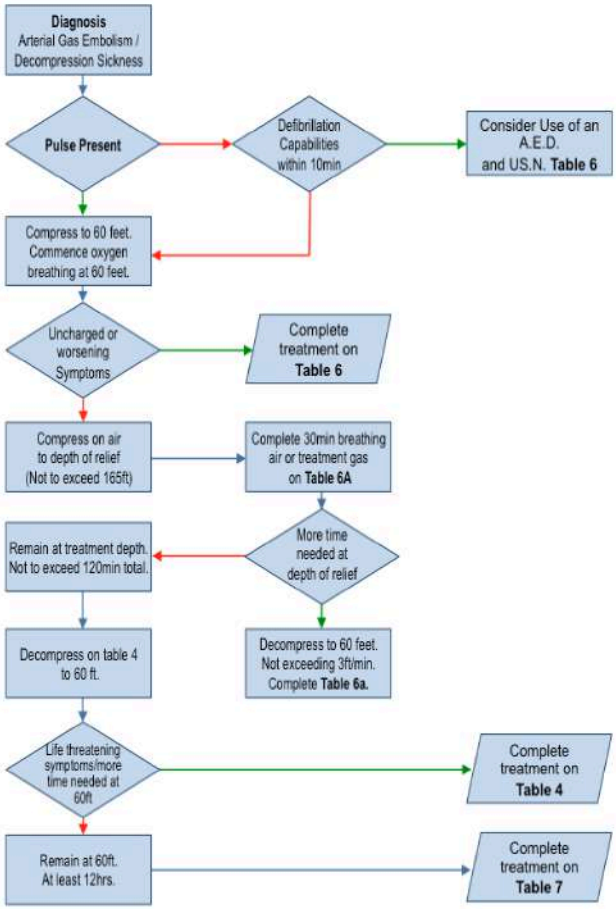
Treatment of D.C.I. 16.2.6

Immediate Actions in D.C.I.

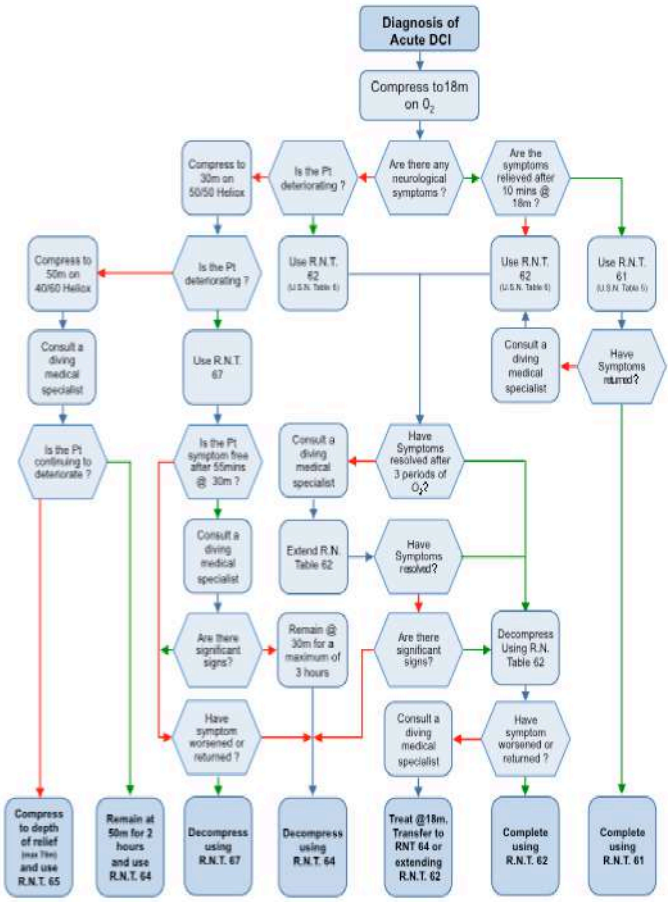
If a diver is suspected of suffering decompression illness the following immediate actions should take place.

- Contact duty medic / supervisor.
- Conduct primary / secondary survey (including full neuro exam) & record observations.
  - Apply D.C.I. manifestation criteria (ONSET – EVOLUTION – SYMPTOMS).
- Lay the casualty flat and administer high flow O_2.
- Implement airway / breathing management.
- Implement Shock Management as indicated.
- Start immediate recompression on appropriate treatment table (as advised by medical specialist or if unavailable company SOP).
  - Use appropriate treatment algorithm such as the R.N or U.S.N.
- Repeat, and complete physical examination when patient is at treatment depth in recompression chamber.
  - Continue to apply treatment algorithm in accordance with the divers condition.

United States Navy D.C.I. Treatment Algorithm



Royal Navy D.C.I. Treatment Algorithm



**The Treatment tables are printed in a full-page format in the DOCUMENTATION section. The R.N. tables are discussed at length in this section.*

ARTERIAL GAS EMBOLISM'S (A.G.E.) 16.3

A gas embolism occurs when a bubble of gas causes a blockage of the blood supply to the heart, brain or other vital tissue. The condition is worsened if the embolism occurs at depth as the bubble will increase in size as the pressure decreases.

When divers hold their breath or have local air trapped in their lungs during ascent, the pressure-volume relationships will cause a rapid over expansion.

Alveoli can rupture or air can be forced across apparently intact alveoli. If air bubbles enter the pulmonary veins, they are swept to the left side of the heart and pumped out into the aorta. Bubbles can enter the coronary arteries supplying the heart muscle, but they are more commonly swept up the carotid arteries to embolise the brain.

As the bubbles pass into smaller arteries, they reach a point where they can move no further and here they occur immediately or within 5 minutes after surfacing.

Pulmonary Arterial Gas Embolism (P.A.G.E.) 16.3.1

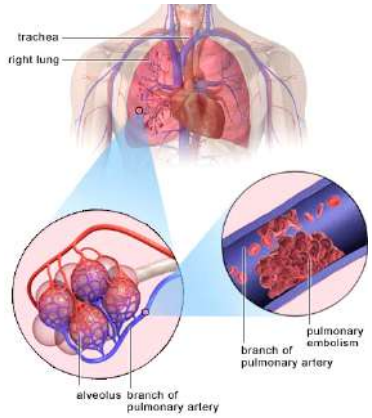
Decompression pulmonary barotrauma is a syndrome, which results in dissolved gas rapidly coming out of solution and entering either the interstitial space within the lung, the pleural cavity or the blood stream.

At the simplest level, if gas that has been breathed while at depth is trapped within the lung during ascent, then the resulting expansion in volume of that gas, in accordance with Boyle's Law, may be sufficient to cause the architecturally delicate pulmonary tissue to rupture and overwhelming the pulmonary filter.

The gas may be trapped as a result of breath holding, or as a result of pulmonary pathology.

Presentation of Pulmonary Arterial Gas Embolism

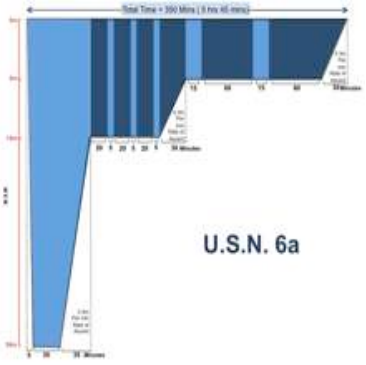
- Rapid onset symptoms (usually < 10 minutes):
  - 9% occur during ascent.
  - 83% occur in less than 5 minutes of surfacing.
  - 8% occur between 5-10 minutes.
- Possible pneumothorax (associated pulmonary barotrauma rupture).
- Abnormal airway signs: **Distress / wheeze / Haemoptesis** (Bloody, frothy sputum).
- Neck Signs: **Trachea Deviation** possible / **distended neck Veins / possible Emphysema.**
- Breathing (RISE – FALL): **rapid Rate / possible aSymmetrical movement / gross Effort & accessory muscle use / hypo-resonant on affected side** / breath sounds: **absent or gross crepitus.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Low SPO_2 levels.
- Cardiogenic shock.
- Chest pain (usually behind the breastbone).
- Neurological signs:
  - Visual disturbances such as blurring.
  - Seizure (Focal / Generalised).
  - Sudden unconsciousness (usually iafter surfacing but sometimes before surfacing).
- Pulmonary / Cardiac Arrest.



Management of Pulmonary Arterial Gas Embolism

- Conduct primary / secondary survey (Including neuro exam) & record observations.
- Contact duty medic / supervisor (URGENTLY).
- Implement tension pneumothorax management as indicated.
- Implement airway / breathing management (ALWAYS initiate O_2, R.S.I. is often required for intubation).
- Implement Shock Management as indicated. (O_2 , I.V.I. etc).
- Positioning the patient in a horizontal -15% inclination.
- Start immediate recompression (as advised by medical specialist or if unavailable company SOP often USN 6a is appropriate).
- Continually assess casualty & record observations.
- Prepare to evacuate (as per company S.O.P's).

A.G.E. Recompression Table (U.S.N. 6a)



Cerebral Arterial Gas Embolism (C.A.G.E.) 16.3.2

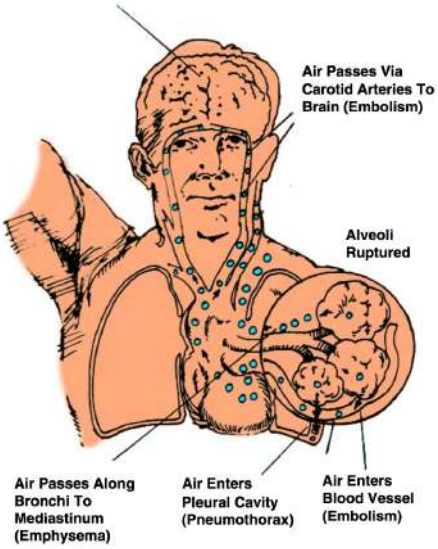
Arterial gas emboli arise from gas bubbles in the pulmonary capillaries, which then pass to the pulmonary veins to the left side of the heart (possibly causing coronary artery emboli). The gas will pass via the internal carotid and vertebro-basilar arteries to the brain.

The gaseous foam or bubbles block arteries of the 30-60 micron and cause distal ischemia and neuronal swelling. As the bubble passes over the endothelium, there are direct cellular effects (within 1-2 minutes). The bubble itself has surface effects causing local swelling, downstream coagulopathy with focal hemorrhages.

There is immediate increased permeability of the blood-brain barrier, loss of cerebral auto-regulation, rise in CSF and a rise in the systemic blood pressure.

CAGE is a life-threatening emergency with the clinical picture of a stroke and requires immediate medical treatment in line with a P.A.G.E.

C.A.G.E.
(Cerebral Arterial Gas Embolism)



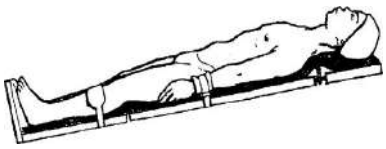
Presentation of Cerebral Arterial Gas Embolism

- Symptoms of P.A.G.E. (including rapid onset).
- Neurological changes;
  - Stroke (F.A.S.T.).
  - Headache.
  - Blindness (partial or complete).
  - Numbness and tingling.
  - Weakness or paralysis.
  - Seizure (Focal / Generalised).
  - Sudden unconsciousness (usually immediate after surfacing but sometimes before surfacing).
- Pulmonary / Cardiac Arrest.

Management of Cerebral Arterial Gas Embolism

- Implement P.A.G.E. management.
- Contact duty medic / supervisor (URGENTLY often evacuation for neurosurgical review is necessary).
- Implement seizure management.
- Implement stroke & cerebral compression management.
  - Often stabilization with ventilation & sedation is mandatory.
  - Maintain a flat or a 15° reverse trandelenberg position.
- Prepare to evacuate (as per company S.O.P's).

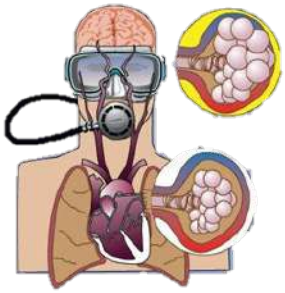
Reverse Trandelenberg Position



BAROTRAUMA'S 16.4

Barotrauma is physical damage to body tissues caused by a difference in pressure between an air space inside or beside the body and the surrounding fluid.

Barotrauma typically occurs to air spaces within a body when that body moves to or from a higher pressure environment, such as when a diver or an airplane passenger ascends or descends, or during uncontrolled decompression of a pressure vessel. Boyle's law defines the relationship between the volume of the air space and the ambient pressure.

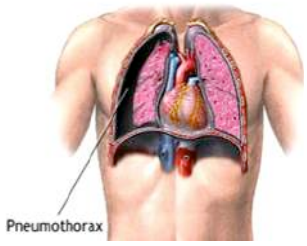


Damage occurs in the tissues around the body's air spaces because gases are compressible and the tissues are not. During increases in ambient pressure, the internal air space provides the surrounding tissues with little support to resist the higher external pressure. During decreases in pressure, the higher pressure of the gas inside the air spaces causes damage to the surrounding tissues if the gas becomes trapped.

Pneumothorax 16.4.1

A pneumothorax may occur when alveolar gas escapes into the pleural space. This is an over expansion injury which has caused alveolar over expansion & rupture.

Over-expansion Pneumothorax



This is not a life-threatening condition because it is possible to survive with one intact lung and it is most unusual for both lungs to be involved simultaneously. Occasionally, the leak is such that gas escapes into the pleural space with each breath, but is unable to return to the lung. Under these circumstances the volume of the pneumothorax gradually increases.

This is known as a tension pneumothorax.

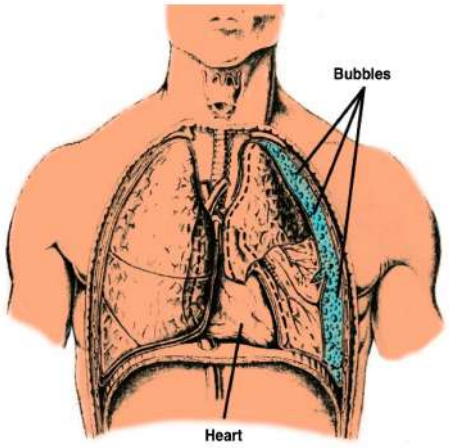
Presentation of a Pneumothorax (severe)

- Commonly the pneumothorax is small and there are few physical signs.
- Abnormal airway signs: **Distress / wheeze.**
- Neck Signs: **Trachea deviation** (late sign) / **distended neck Veins / Emphysema present / L**arynx intact.
- Breathing (RISE – FALL): **rapid Rate** / **aSymmetrical movement** / **gross Effort & accessory muscle use** / **Feel emphysema / hyper-resonant on affected side** / breath sounds: **absent on affected side.**
- Difficulty speaking (will need to take a breath in the middle of a sentence).
- Painful breathing / complain of chest pain.
- Rapid pulse rate (tachycardia).
- Non-palpable radial pulse (Reduced blood pressure).

Right Sided Pneumothorax

- Reduced conscious level (cerebral hypoxia).
- Pale, clammy skin / Grey or blue lips and skin (cyanosis).

Closed Pneumothorax



Management of a Pneumothorax

A Small Pneumothorax Can Be Treated Conservatively:

- Contact duty medic / supervisor.
- Conduct primary / secondary survey & record observations.
- Administer high flow O_2 on the surface.

Large Pneumo-Thoraces And **All** Tension Pneumothoraces Require Draining.

- Conduct primary / secondary survey & record observations.
- Implement compromised airway / breathing management.
- Alert Medical personnel / supervisor & prepare to evacuate.
- Observe for & treat A.G.E.'s.
- Assess for tension pneumothorax & implement treatment if present.
- Treat Shock. (Always Insert an I.V. cannula, give I.V. fluid as instructed).
- Continually assess casualty.
- If casualty is in a hyperbaric environment be aware that it can evolve into a tension pneumothorax on ascent.

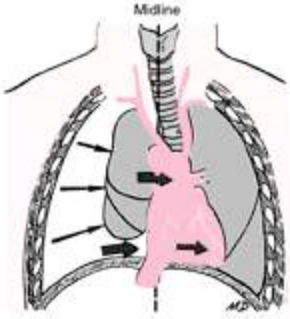
Tension Pneumothorax 16.4.2

This dangerous condition has already been discussed (section 3.2.7). With regards to diving, a Tension Pneumothorax is almost exclusively an over expansion event. The presence of a diving over expansion tension pneumothorax is related an increased incidence of A.G.E's and D.C.I. in the victim.

Presentation of Tension Pneumothorax

- Standard Tension Pneumothorax presentation.
- Possible P.A.G.E. / C.A.G.E.
- Possible Neurological / musco-skeletal D.C.I.
- Mediastinal and subcutaneous emphysema in neck / shoulders.

Over-Expansion
Tension Pneumothorax



Management Of Tension Pneumothorax

- Contact duty medic / supervisor.
- Conduct primary / secondary survey & record observations.
- Administer high flow O_2 on the surface.
- Implement Tension Pneumothorax treatment (See clinical skills 3.2.7)
  - Needle Decompression should always include a Heimlich valve in a chamber environment.
- Implement shock management. (O_2, I.V.I. etc).
- Implement A.G.E. / D.C.I. / Mediastinal and subcutaneous emphysema management.
- Continually assess casualty & record observations.
- Prepare to evacuate (as per company S.O.P's).
- A trained medic should place a chest drain on the affected side as soon as possible.

Mediastinal and Subcutaneous Emphysemia 16.4.3

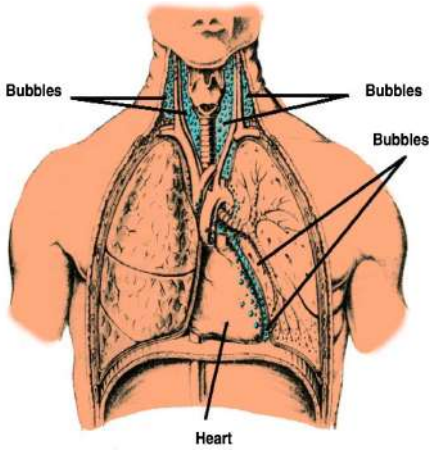
If gas escapes into the interstitial tissue space, it may track along the outside of the airways and blood vessels to the hila of the lungs and from there into the mediastinum.

This is the space between the lungs, which contains the heart, great vessels, and major airways. The presence of a little gas in the mediastinum is often symptomless.

Occasionally, considerable quantities of gas escape from the lung and this may track down into the abdomen and, rarely, the pelvis. The gas is retroperitoneal and may outline the liver and kidneys. It is unusual for such gas to generate symptoms.

However, if tissues are stretched by a substantial amount of gas, may be felt.

Mediastinal Emphysema



Presentation of Mediastinal And Subcutaneous Emphysemia.

- Often symptomless.
- A change in the tone of the voice or hoarseness.
- Swelling or crepitation (the skin "crackles') in the neck & face.

- A sensation of fullness in the chest or throat.
- Mild to moderate retrosternal pain.

Subcutaneous Emphysema

Management Of Mediastinal And Subcutaneous Emphysemia.

- Usually resolves gradually without specific treatment.
- If there are troublesome symptoms, resolution will be accelerated by:
  - Giving 100% O_2 on the surface.
  - Recompression as per company S.O.P. (in the very rare instances where there are serious symptoms).

BAROTRAUMA SQUEEZE'S 4.5

A *squeeze* occurs whenever fixed volume gas spaces within the body or diving gear are not pressure counterbalanced to surrounding depth.

The human body automatically adjusts to any change in the pressure of the surrounding environment; it usually does so without the person involved noticing the change.

Most of the body is composed of plasma that can transmit imposed pressure without deformation, but there are a few areas where this is not true. If the gas pressure within some air-filled cavities of the body, such as the middle ear or the bony sinuses of the skull, is not easily equalised with the surrounding pressure, an individual undergoing even mild pressure changes (such as those that occur diving or flying) may be aware of the pressure difference.

In more severe cases, pain, accompanied by fluid and blood in the middle ears and sinuses, may be the result of a "squeeze" in these areas.

Such effects are exaggerated in divers because the water that surrounds them is much denser and heavier than air. The ability of diving equipment automatically to deliver breathing gases that are the same pressure as the surrounding depth of water makes diving possible, but these compressed gases must infiltrate into all the rigid bony cavities (the middle ear, sinuses, and chest cavity) to equalise the pressure inside, or the resulting deformations will lead to pain caused by compression and contraction of tissues.

If the pressure difference is allowed to increase, blood vessels may haemorrhage and rupture.

Types of Squeezes Include:

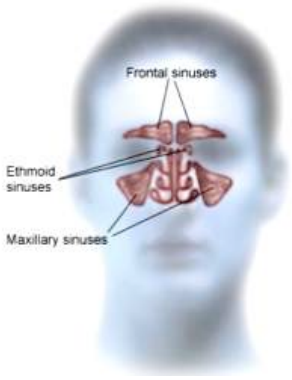
- Sinus Squeeze.
- Ear squeeze.
- Thoracic Squeeze.
- Face or Body Squeeze.
- Tooth Cavities Squeeze.

Sinus Squeeze 16.5.1

The sinus cavities are air pockets located within the skull bones that have openings into the nasal passages. These cavities are lined with a mucous membrane.

Sinus squeeze normally is the result of diving with a cold or head congestion. Adequate ventilation and pressure equalisation in the para-nasal sinuses are important in diving. Both descent and ascent depend to a large degree on adequate nasal function. Inflammation and congestion of the nasal mucosa caused by allergies, smoking, chronic irritation from prolonged or excessive use of nose drops, upper respiratory tract infections, or structural deformities of the nose can result in blockage of the para-nasal sinus openings.

Sinus Squeeze



The inability to equalise pressure on descent creates negative relative pressure within the sinus cavity, deforming the mucous membrane and causing swelling, fluid exudation, haemorrhage, and pain. Para-nasal sinus barotrauma also may occur during ascent. The key mechanism is thought to be one-way blockage of the sinus opening by cysts or polyps located within the sinus that allow pressure equalisation during descent but not during ascent.

Presentation of Sinus Squeeze:

- Sensation of fullness or pain over the involved sinus or in the upper teeth.
- Numbness of the front of the face.
- Bleeding from the nose.

Management of Sinus squeeze:

- Appropriate equalization technique.
- Cessation of compression / ascending.
- Nasal vasoconstrictors / oral antihistamines (To promote nasal mucosal shrinkage of the sinus.)
- If severe pain and nasal bleeding are present or if there is a yellow or greenish nasal discharge, with or without fever, a specialist should be seen promptly.
- Individuals with a history of nasal-sinus disease should have an E.N.T. evaluation before beginning to dive.

External Ear Squeeze 16.5.2

Injury to the external ear canal due to inability to equalise the external ear space as a result of an obstruction. This is generally caused by tight hoods, ear-plugs, and most commonly wax. In this case, if the Eustachian tube is functioning normally, the pressure in the external ear canal is negative relative to the outside atmosphere, the air in the nose and in the middle ear. The ear drum bulges outwards, blood and tissue fluid is forced under the skin of the external ear canal forming blood blisters and ultimately the ear drum may rupture.

Notable presentation includes severe ear pain and possible inflammation of the external ear canal. Worsening of this condition by increasing the pressure differential may lead to a ruptured eardrum resulting from the squeeze.

Rupture may occur with as little as 100 hGmm difference between the external auditory canal and the middle ear (only 1metre of sea water).

Presentation Of External Ear Squeeze:

- Fullness or pressure in region of the external ear canals.
- Pain.
- Blood or fluid from external ear.
- Rupture of ear-drum (entrance of cold water into the middle ear).
  - Extreme dizziness (vertigo).
  - Nausea, and possible vomiting.

External Ear Squeeze

Management of External Ear Squeeze:

- Appropriate equalization technique.
- Cessation of compression / ascending.
- Ear-drum rupture should be treated according to the procedures for treating middle ear barotraumas.

Middle Ear Squeeze 16.5.3

This is the most common transient ear problem associated with diving or barotrauma. It is defined as physical damage between the eardrum and eustachian tube, which is caused by inadequate pressure equalisation between the middle ear and the external environment.

Most commonly it is due to blockage of the Eustachian tubes, with catarrh or mucus. Nasal conditions such as congestion and discharge increase the likelihood of poor eustachian tube function during the dive. Absence of pre-dive symptoms does not guarantee that a diver will not develop middle ear barotrauma.

Presentation Of A Middle Ear Squeeze:

- The symptoms of middle ear squeeze consist initially of pain and a sensation of ear blockage.
- Conductive hearing loss (but may not be the primary complaint because of the intense ear pain).
- Mild tinnitus and vertigo.
- Blood in middle ear / eardrum.
- If the ear drum ruptures;
  - The pain is usually relived.
  - Cold water may enter the middle ear causing:
    - Dizziness.
    - Nausea.
    - Ringing in ears.
    - Acute or chronic infection with resultant temporary or permanent deafness.
- Excessive Valsalva manoeuvre may cause damage to the oval window.

Management of Middle Ear Squeeze:

- Divers should attempt to re-establish pressure balance as quickly as possible.
- If unable to resolve this difficulty quickly, the diver should ascend to the surface.
- Often, returning to the surface is all that is necessary to relieve the symptoms of mild ear squeeze, (but it may take a few days for the fluid or blood to drain from or be absorbed from the middle ear cavity).
- A nasal decongestant spray, nose drops, a mild vasoconstrictor medication, or an antihistamine taken by mouth may help.
- Chewing gum, yawning, or swallowing may also help.
- If examination reveals that the diver has a rupture of the ear drum, the diver should:
  - Be seen by a physician.
  - Stay out of the water until the tear has healed, which usually occurs quickly (unless an infection in the ear delays the repair process).
  - Monitor the healing process and take steps to control infection in the damaged ear.

Barodontalgia (Tooth Cavities Squeeze) 16.5.4

Pain or injury of a tooth or a filling caused by increasing pressure on faulty fillings or decayed teeth.

Airspace underneath a filling may cause implosion on descent, a venting tooth cavity may fail on ascent leading to explosion of filling from tooth, or in extreme cases the tooth itself may explode.

Barodontaglia

Presentation Of Tooth Squeeze:

- Pain in affected tooth and maxillary sinus pain.
- Tooth may implode.

Management Of Tooth Squeeze:

- Stop descent - return to surface.
- Analgesic management as required.
- Dental review.

Face or Body Squeeze 16.5.5

This is caused by sudden non-equalisation of a facemask, suit, or hardhat resulting from failure of surface gas supply / non-functioning of non-return valve, or a rapid increase in depth without compensating gas pressure.

Pain caused by local tissue compression and possible haemorrhage of blood vessels in affected tissue.

Presentation of Face / Body Squeeze:

- Pain around eyes and the site of the squeeze.
- Blood-shot eyes.
- Bleeding into skin, around eyes, or from nose may occur.
- Puffed-swollen cheeks.

Face Squeeze

Management of Face / Body Squeeze:

- Mild - none.
- Severe - stop diving until clear.
- Analgesia medication as necessary.

Thoracic (Lung) Squeeze 16.5.6

This barotrauma is caused by compression of lungs to less than their residual volume resulting from an extremely deep free dive (breath holding) or pronounced body squeeze.

May cause lung damage due to blood and tissue fluids being forced into the alveoli and air passages.

Presentation Of Thoracic Squeeze:

- Feeling of chest compression during descent.
- Pain in the chest.
- Difficulty in breathing on return to the surface.
- Bloody sputum.

Management Of Thoracic Squeeze:

- In severe cases, the diver requires assistance to the surface.
- Implement reduced consciousness care.
- Implement airway / breathing interventions.
- Medically assess & evaluate.

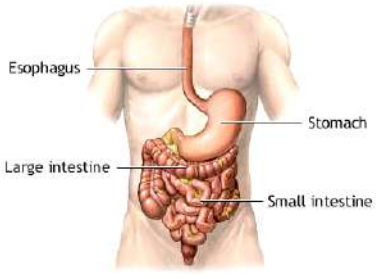
G.I.T. Barotrauma 16.5.7

Discomfort in the stomach and / or bowel due to distension with expanding gas. This is caused by trapped gas expanding on ascent.

Divers become more susceptible to this condition after; air swallowing at depth, drinking fizzy drinks (particularly during a chamber dive) or using effervescent medication before the dive.

Presentation of Gastrointestinal Expansion

- Abdominal discomfort.
- Abdominal pain (sharp in nature.).



Management of Gastrointestinal Expansion

- Usually self-curing by belching or passing wind.
- If severe, slow down rate of ascent.
- If occurring in chamber; chew peppermints.

DISORDERS OF DIVING 16.6

Adiabatic Compression 16.6.1

Adiabatic compression is the term used to explain Charles's Law relation to diving. Temperature increases with pressure. In a hyperbaric vessel (decompression chamber or bell), temperature will increase on compression (when the bell is blown down or the chamber pressurized).

It is important that pressurization speeds set down by your diving company are not exceeded.

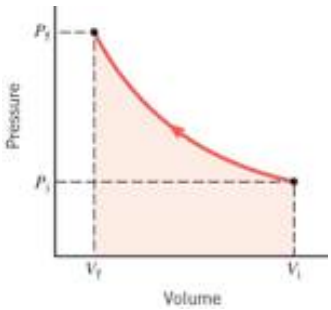
Oxy/Helium is about 6 times more heat conductive than air, if the humidity is high (over about 85%), then the body's ability to sweat and loose heat is reduced, resulting in an increase risk of heat exhaustion / stroke.

Normally the chamber environment should be maintained around 27 or 28°C and 75% humidity.

Prevention of Adiabatic Compression:

- Do not exceed pressurisation speeds.
- Monitor chamber temp during compression (check temp reader is calibrated).
- Do not overheat chamber prior to compression.
- Keep chambers in hot climates shaded.

Adiabatic Compression



Management of Adiabatic Compression:

- Conduct primary / secondary survey & record observations.
- Douse chamber exterior with cold water (cover with blankets and soak).
- Flush chamber with correct mixture.
- Decompress if emergency (chamber atmosphere will cool down).
- Use chamber heating system (if appropriate) on "cold cycle" to act as "heat sink".
- Cool occupants with cold water (shower, ice, sponge), and give cool fluids
- Implement heat illness measures for chamber occupants.
- Seek medical advice from duty medic.

Aseptic Bone Necrosis 16.6.2

Aseptic bone necrosis is dead bone tissue in the absence of infection or disease process occurring in part of a bone, which is otherwise normal. This is thought to be caused by an absence of a blood supply to part of the bone due to condition such as trauma, iatrogenic (physician-induced) side effects of treatment using steroids or radiation, some blood disorders or alcoholism. Aseptic bone necrosis is often referred to as Avascular Necrosis.

Towards the end of the last century, aseptic bone necrosis was found to occur in men who worked in caissons; as a result this condition was originally known as Caisson Disease of Bone.

Dysbaric Osteo-necrosis (DON) 16.6.3

This is aseptic bone necrosis occurring in divers and compressed air workers. The earliest description of this condition was in 1888 and X-ray findings were first described in compressed air workers in 1911.

The condition was first described in divers in 1941. It is thought to be a chronic occlusion of bone blood vessels by bubbles or other mechanisms related to accumulation of gas in the tissues.

Lesions have been seen in 17% of caisson workers and definite lesions in 3% of commercial divers.

DON generally affects the; humerus, femur and tibia.

Dysbaric Osteo-necrosis

Presentation of Dysbaric Osteo-necrosis;

- Possibly symptomless.
- Sudden and persistent pain in a joint.
- Gradually increasing pain, stiffness and loss of movement of a joint;
  - Indicating the development of degenerative arthritis.

Management of Dysbaric Osteonecrosis

- If DON is discovered ceasing diving is recommended.
- Severe lesions will require orthopedic surgical intervention.

High Pressure Nervous Syndrome (HPNS) 16.6.4

High Pressure Nervous Syndrome (HPNS) is a derangement of central nervous system function that occurs during deep helium/oxygen dives, particularly saturation dives.

The cause is unknown. HPNS is first noted between 150m – 200m, and the severity appears to be both depth and

compression rate dependent.

With slow compression, depths of 350m may be achieved with relative freedom from HPNS.

Beyond that, some HPNS may be present regardless of the compression rate.

Attempts to block the appearance of the syndrome have included the addition of nitrogen or hydrogen to the breathing mixture and the use of various drugs. No method appears to be entirely satisfactory.

Presentation of HPNS:

HPNS

- Nausea.
- Fine tremor – imbalance.
- Coarse tremor.
- Loss of manual dexterity - In-coordination.
- Jerky movements.
- Loss of alertness - Disorientation.
- Abdominal cramps and diarrhoea develop occasionally.
- In animal experiments convulsions have also been recorded.
- In severe cases; vertigo, extreme indifference to his surroundings, confusion.

In 1965 the Royal Navy Physiological Laboratory was conducting a series of deep dives in a compression chamber to depths of 200 – 350m. The condition appeared to improve after 90 mins at depth, and the subjects gradually returned to normal.

EXAMPLE: In a series of dives, the following symptoms were reported. Using a compression rate of 2.5m/min without rest stops:

- At 200m: Tremors appeared.
- At 240m: Changes in the brain activity was recorded by electro-encephalogram.
- At 320m: Development of muscular in-coordination.
- At 330m: Subjects beginning to experience loss of alertness.
- At 350m: Subjects develop extreme indifference, and decreased comprehension.

Some reports have recorded bouts of sleep occurring from which the subject is readily awakened.
Difficulty in right-left orientation has also been reported.

The development and severity of High-Pressure Nervous Syndrome appears to be related to the rate of compression at great depths being particularly more noticeable at faster rates.

Investigations into other possible contributory causes, such as the effects of oxygen, carbon dioxide, temperature, and fluid shift within the tissues due to gas pressure, have been found to have little, or no part in the incidence of HPNS.

It has been found that the inclusion of nitrogen, or other heavier narcotic gases has significantly reduced the cost of the mixture, alleviated the effects of voice distortion, and reduced the dangers of excess heat loss. For this reason it is common to use a "TRI-MIX" of oxygen, nitrogen and helium when diving deeper than 200m.

Prevention / Management of HPNS:

- Follow the general rule, "the deeper the dive, and the slower the rate of compression".
- Use appropriate gas mix.
- Include rest stops on compression.
- Monitor divers closely for signs of HPNS.
- Exclude – abort diver with severe symptoms.

Hydrostatic Nervous Syndrome 16.6.5

A similar condition to High Pressure Nervous Syndrome may occur when the subject has been exposed to extreme depths for long periods. It is **not** dependent on rate of compression.

Although the symptoms of this condition are similar to those of HPNS, the exact mechanism of this action is not fully understood. The main difference is in its occurrence after the depth has been stable for some time. The main form of treatment in both cases when symptoms are severe is to gradually decompress the individuals involved until the symptoms disappear.

Compression Arthralgia 16.6.6

Hyperbaric arthralgia is pain in the joints due to raised ambient pressure.

A diver suffering from hyperbaric arthralgia sometimes hears a creaking and cracking from his joints and feels as if his joint surfaces are dry (no "joint fluid"). Joints hurt especially on movement. The condition is aggravated by a too-rapid compression.

A compression rate of not more than 1m / min often avoids the painful effects of this condition although the cracking of the joints continues.

Compression Arthralgia

Tinnitus 16.6.7

Tinnitus or spontaneous noise or ringing in the ear can occur with middle ear disease that causes a conductive hearing loss, in terms of diving a perilymphic fistula or audio-vestibular DCI (very rare) may be the underlying cause. but it is usually associated with inner ear or brain disease.

HEARING LOSS Is Classified In To Three Categories:

- Conductive hearing loss, caused by;
  - Complete occlusion of the external auditory canal by wax.
  - Inflammation, swelling of the ear-drum or lining of the middle ear.
  - Fluids in the middle ear.
  - Changes in middle ear gas densities, pressure gradients across the ear drum.
  - Fixation of the ear bones, or loss of elasticity of the eardrum caused by scaring or large perforations.
- Neuro-sensory or nerve hearing loss, caused by nervous or vascular insufficiency in the inner ear;
  - Head injury.
  - Stroke.
  - Bubbles (DCI).
  - Round or oval window rupture.
  - Excessive noise exposure, or various other inner ear disease or conditions.
- Mixed or combined conductive and neuro-sensory hearing loss caused by simultaneous dysfunction of the middle and inner ear.

Management of Tinnitus:

- Seek ENT specialist review.
- Treat underlying cause of Tinnitus.

Vertigo 16.6.8

The occurrence of vertigo underwater is dangerous, being a potential cause of fatal underwater accidents. Normal balance under physiological conditions on dry land is maintained by the inter-action of gravity and a series of sensory organs. Joints and muscles, vision, and the vestibular organs all give complementary information to the brain about position in space, movements etc.

Underwater a profound change takes place. Buoyancy reduces the value of clues from joints and muscles. Darkness precludes visual clues and a great deal more reliance is placed upon sensations from the semi-circular canals and the vestibular apparatus generally.

Under calm conditions a diver gains extra clues from incidental observations such as bubble streaming, and buoyancy of objects with known behaviour at the depth involved, but under emergency or panic conditions this information too may not be available and sensation from the ear organs becomes a vital matter for survival.

DCI can cause gas release in the semi-circular canals or vestibule, causing physical disruption of the hair cells, which detect the relative movement of the labyrinthine fluids.

Vertigo

Presentation of Vertigo:

- False sensations of movement of the subject or of his surroundings, known as vertigo.
- Spinning sensation, such as is felt after getting off a roundabout.
- Swaying or falling sensation.
- Nystagmus – (a flickering movement of the eye).
- Severe nausea.

Management of Vertigo:

- Gain orientation as soon as symptoms of vertigo present.
- Report episodes & undergo review by dive doctor.
- Treat underlying cause.

Alternobaric Vertigo 16.6.9

Unequal or asymmetrical clearing of the middle ear during descent or ascent, and particularly during ascent, can cause vertigo. Regardless of the cause, vertigo and its spatial disorientation are hazardous if they occur during a dive.

Management of Alternobaric Vertigo

- Avoid diving if; there is difficulty clearing ears or if a Valsalva manoeuvre on the surface produces vertigo.
- If there is vertigo, ear blockage or ear fullness during compression, they should;
  - Stop any further descent.
  - Ascend until the ears can be cleared.

Omitted Decompression 16.6.10

In situations such as blow-up, loss of air supply, bodily injury or other emergencies, a diver may be required to surface prematurely, without taking the required decompression.

Surface decompression has been a recognised feature of commercial diving for many reasons for decades. It has earned the title 'bend and mend' as an overall policy.

Management of Omitted Decompression;

- Use appropriate tables / company procedures for surface decompression.
- Be suspicious. Observe diver for possible dysbaric condition (D.C.I. / A.G.E. / barotrauma).
  - If present apply appropriate treatment & compression table.
- If the diver shows no ill effects from omitted decompression, the diver should;
  - Be monitored for at least 4 hours.
  - Stay within the vicinity of a recompression chamber for 24-48hrs.
- Recompression may be considered as a precaution.
- In-water treatment for omitted, asymptomatic decompression should **not be performed**.

Surface Decompression

DECOMPRESSION THERAPY 16.7

It is important that a D.M.T. orientates themselves to their company's S.O.P.'s with regards to treatment of DCI with compression therapy.

Standard recompression algorithms are readily available, but it is not uncommon for specific operators to modify or enhance treatment algorithms.

In the Miscellaneous Section we have included both the Royal Navy & the United States Navy D.C.I. Management algorithm as examples of possible treatments that a Duty Medic may instigate.

We have included a 'Tender Responsibilities' section in this chapter, which highlights the R.N. Tables 66, 62 & 67. These responsibilities can be altered to suit any chamber.

Personnel Requirements For Chamber Operations

The minimum team for conducting any recompression operation consists of a Diving Supervisor, an inside Tender D.M.T., outside Tender and depending on the circumstances, a Diving Physician.

Diving Supervisor

The diving supervisor is in charge of the operation and must be familiar with all phases of chamber operation and treatment procedures. The supervisor must ensure that communication, logging, and all phases of treatment are as per company SOP's.

Diving Physician

The diving physician is trained in the treatment of diving accidents. Although it may not be possible to have a diving physician present during all treatments, it is essential that the diving supervisor be able to consult by telephone or radio with a diving physician.

Chamber Tender / DMT

The inside tender / DMT must be familiar with all treatment procedures and with the signs, symptoms and treatment of diving related injuries and illnesses. They are responsible for the direct care of the casualty & communicating their condition with the dive supervisor / duty medic.

Choosing the Right Personnel

When a recompression treatment is conducted for pain-only decompression illness, an experienced physician or DMT should tend the patient inside the chamber.

If it is known before the treatment begins that specialised medical aid must be administered to the patient, or if a gas embolism is suspected an appropriately trained medic should accompany the patient inside the chamber. If the chamber is sufficiently large, a second tender may also enter the chamber to assist during treatment. Inside the chamber, the tender ensures that the patient is lying down and positioned to allow blood circulation to limbs.

When a diver is being recompressed, all the tending personnel must work as a team for the benefit of the patient. Whether the inside or the outside tender operates the chamber will be dictated by the availability of qualified personnel and the circumstances of the casualty being treated.

If the patient has symptoms of serious DCI or gas embolism, the team will require additional personnel. If the treatment if prolonged, a second team may have to relieve the first.

Whenever possible, patients with serious DCI or gas embolism should be accompanied inside the chamber by a DMT or a diving physician, but treatment **should not** be delayed to comply with this recommendation.

Effective recompression treatment requires that all members of the treatment team be thoroughly trained and practised in their particular duties. It is also advisable to cross train members to carry out the duties of their teammates.

Chamber Attendant / D.M.T. Responsibilities 16.7.1

State Of readiness

Since a recompression chamber is emergency equipment, it must be kept in a state of readiness. The chamber needs to be well maintained and equipped with all necessary accessory equipment. *A chamber is not to be used as a storage compartment.*

Key Responsibilities Include:

- Ensuring that the pre-dive checklist is completed.
- Ensuring the cleanliness of the chamber interior.
- Ensuring provision of chamber medical supplies in line with SOP's / DMAC regulations.
  - Ensure medical specific items are available in line with patient needs.
- Effectively communicating with the chamber supervisor.
- Ensuring the patient does not carry forbidden items into the chamber.
- Are there factors that preclude the casualty from the treatment:- of a cold / flu, a toothache or pregnancy.
- Fully assess patient:
  - Providing assistance with the patient's activities of daily living as required.
- Ensuring exhaust & equalization valves are in the 'closed' position.
- The tender manually ensures the seal of the inner lock.
- Ensuring the patient's wear hearing protection during various treatment stages (descent, and flushing).
- Monitor the patient's for aural discomfort, halting the ascent as required until the pain has been relieved.
  - Administrating treatment gas to the patient when instructed by the chamber supervisor.
  - Monitor effects of treatment gas.
  - Ensuring that the patient's are in a position that permits free blood circulation to all extremities.
  - Ensuring that BIBS mask is comfortable, well sealed and free of gas leaks.
- Discontinuing treatment gas to the patient when instructed by the chamber supervisor.
- Providing normal assistance to the patient's as required.
- Providing first aid as required by the patient's.
- Responding to any internal chamber emergencies in accordance with S.O.P's.
- Assisting in post treatment chamber / BIBS cleaning.
- Preparing chamber for subsequent treatment.
- Ensure the completion of the post-dive checklist.

General Chamber Safety Precautions:

- Do not use oil / petroleum based products on or anywhere near the chamber or associated equipment.
- Ensure the securing dogs (medical lock) are in good operating condition and seals are tight.
- Do not allow open flames, smoking materials, or any flammables to be carried in the chamber.
- Do not permit electrical appliances to be used in the chamber (unless verified by SLST).
- Ensure the patient's does not interfere with chamber operations.
- Do not permit products in chamber that may contaminate or off-gas into the chamber atmosphere.

Tender Decompression Needs

The experience of being in a hyperbaric chamber physiologically is identical to diving. And just like scuba diving the length of time an attendant can stay at depth is dictated by how much nitrogen they absorb from the air (79% of air is nitrogen).

All chamber supervisors are highly experienced diving supervisors who are experts at calculating tenders decompression needs in accordance with internationally recognized dive tables.

During various stages of the treatment table the chamber attendant is instructed to 'go on oxygen'.

This has two actions. Firstly, no further nitrogen is being breathed and therefore any accumulation of the gas ceases. Secondly the attendant will actually 'off gas', as absorbed nitrogen will be removed at an accelerated rate due to an increased osmotic pull.

Tenders should not fasten the oxygen masks to their heads, but should hold them on their faces. The risk of the tender getting oxygen toxicity is amazingly low (they only consume a fraction of the oxygen that the patient does). If however the tender does experience oxygen toxicity, the exclusion of head straps ensures that the oxygen will simply fall away from the airway.

U.S. Navy Dive Tables

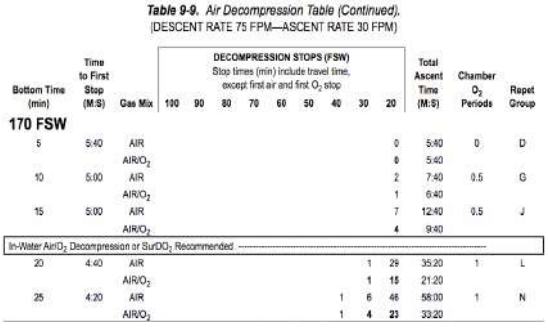


Table 9-9. Air Decompression Table (Continued).
(DESCENT RATE 75 FPM—ASCENT RATE 30 FPM)

Bottom Time (min)	Time to First Stop (M:S)	Gas Mix	DECOMPRESSION STOPS (FSW) Stop times (min) include travel time, except first air and first O_2 stop: 100	90	80	70	60	50	40	30	20	Total Ascent Time (M:S)	Chamber O_2 Periods	Repet Group
170 FSW														
5	5:40	AIR									0	5:40	0	D
		AIR/O_2									0	5:40		
10	5:00	AIR									2	7:40	0.5	G
		AIR/O_2									1	6:40		
15	5:00	AIR									7	12:40	0.5	J
		AIR/O_2									4	9:40		
In-Water Air/O_2 Decompression or SurDO_2 Recommended														
20	4:40	AIR								1	29	35:20	1	L
		AIR/O_2								1	15	21:20		
25	4:20	AIR							1	6	46	58:00	1	N
		AIR/O_2							1	4	23	33:20		

Royal Navy Table 62 Recompression Therapy (U.S.N. Table 6) 16.7.2

This table is used for the great majority of cases of DCI. Its use is dictated by patient response in the treatment algorithm.

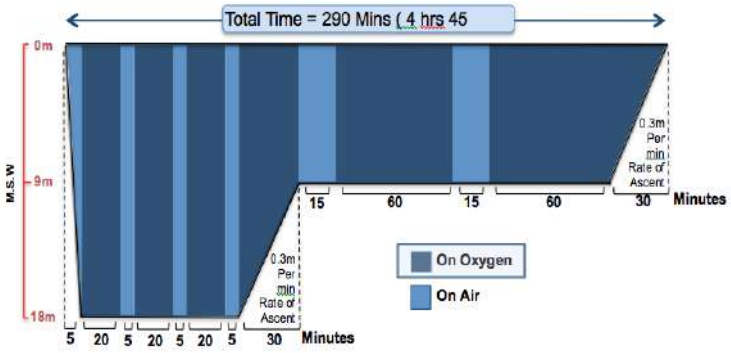
Proceed As Follows:

- Descend to 18m over 3-5 minutes stopping only if the patient or attendant has difficulty in clearing their ears.
- The timing of the treatment starts on reaching 18m.
- Upon reaching 18m the patient is re-assessed.
  - The assessment should take no more than 2-3 minutes.
  - The patient's condition to have stabilised or improved, if the algorithm is followed strictly, the decision to change to R.N. Table 61 may be made (however many specialist believe that the R.N.T. should always be completed).
  - However, patients who have presented with serious symptoms may continue to deteriorate at 18m. In such cases, the chamber should be compressed to 30m on air with the patient breathing 50/50 Heliox (50% oxygen / 50% helium). Decompression will then normally be completed using RN Table 67.
- If the time between reporting symptoms and receiving treatment is greater than 8 hours or if the symptoms have remained static or improved incompletely after three 20 minute periods on 100% O_2 at 18m, RN Table 62 may be extended with one or two further O_2 breathing periods, separated by a 5 minute air break.
- If the signs and symptoms have not resolved after 2 extensions at 18m further advice from the diving medicine specialist should be sought.
- Symptoms may recur during ascent to 9m or at 9m. In such circumstances;
  - STOP THE ASCENT and return to 18m.
  - Consult a Diving Medicine Specialist.
- RN Table 62 may be extended for one or two 1 hour O_2 breathing periods at 9m, separated by 15 minutes air breaks.

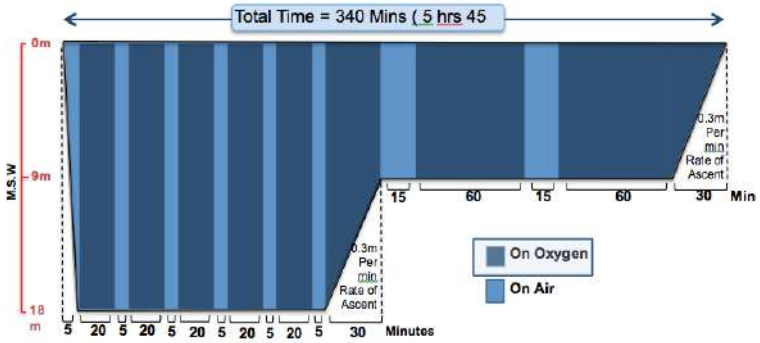
Attendant Decompression Needs;

- For an unmodified R.N.T. 62 or a R.N.T 62 with one extension, at 9m or 18m, the attendant must:
- Breathe O_2 for the last 30 minutes at 9m and during the ascent from 9m to the surface (60 minutes in total). If RN Table 62 is extended more than once, then the attendant should breathe O_2 for the whole of the final O_2 period at 9m and the ascent to the surface (90 minutes in total).
- If the attendant has undergone a hyperbaric exposure in the preceding 24 hours, an additional 60 minute period breathing O_2 at 9m (150 minutes in total) should be undertaken.

Royal Navy Table 62



Royal Navy Table 62++ (with 2 extensions)



Royal Navy Table 67 Recompression Therapy 16.7.3 (Comex 30 Heli/Ox)

This table, a modified version of the COMEX 30 table, is to be used for the treatment of more serious or more threatening cases of D.C.I.

These Cases Include;

- Gross Neurological symptoms within 24hrs of diving.
- Diving deeper than 50m.
- Diving on mixed gas.
- The patient continues to deteriorate following an initial compression of 18m on 100% O_2.
- Omitted decompression on very deep dives, when the diver has completed less than 15 minutes of stops and the

stops missed were at depths in excess of 18m.
- On the advice of a Diving Medicine Specialist for the treatment of DCI.

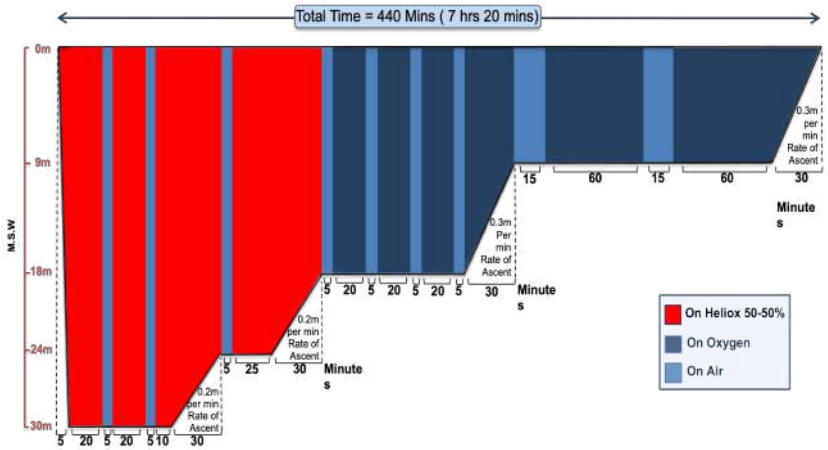
Proceed As Follows:

- The patient starts breathing 50:50 O_2:He on the surface, or from 18m when transferring from RN Table 62.
- Descent to 30m over 5-10 minutes stopping only if the patient or attendant has difficulty in clearing their ears.
- The timing of the treatment starts on reaching 30m.
- Upon reaching 30m the patient must be reassessed.
  - This assessment should take no more than 2-3 minutes.
- If symptoms have remained static or improved incompletely after 55 minutes at 30m up to 5 additional 20 minute periods breathing 50:50 O_2:He, separated by 5 minute air breaks, may be added on the advice of Diving Medicine Specialist.
  - On completion of extensions decompression should be by RN Table 64 with 50:50 O_2:He breathed during the ascent from 30-24m.
  - A 5 minute air break is taken on arrival at 24m with 50:50 O_2:He breathed during the remaining 25 minutes of the 24m stop and the ascent from 24-18m.

Attendant Decompression Needs;

- For an unmodified RN Table 67 the attendant must breathe O_2 during both 60-minute O_2 periods at 9m and during the ascent from 9m to the surface (total 150 minutes).
- If the RN Table 67 is extended at 18m, by either one or two additional O_2 periods, it must also be extended by an additional 60 minute O_2 period at 9m during which time the attendant is to breathe O_2 (210 minutes).
- If the RN Table 67 is extended at 9m the attendant must breathe O_2 for an additional 60-minute period (total 210 minutes).
- If the attendant has undergone a hyperbaric exposure in the preceding 24 hours RN Table 67 should be extended at 9m to permit the attendant to breathe O_2 for an additional 60-minute period (total 210 minutes).

Royal Navy Table 67



Failure Of Recompression Treatment 16.7.4

Four major complications may effect the recompression treatment of a patient.

These Are:

- Worsening of the patient's condition during treatment.
- Recurrence of the patient's original symptoms or development of new symptoms during treatment.
- Recurrence of the patient's original symptoms or development of new symptoms after treatment.
- Failure of symptoms of decompression illness or gas embolism to resolve despite all efforts using standard treatment procedures.

When any of these complications occurs, the advice of diving medicine experts should be sought immediately, because alternative treatment procedures have been developed and used successfully when standard treatment procedures have failed.
These special procedures may involve the use of saturation diving decompression schedule; cases of this type occur more frequently when a significant period of time has elapsed between the onset of symptoms and the initial recompression.

GAS TOXICITY 16.8

Gas toxicity is defined as ill health caused by absorbing airborne gas via the:

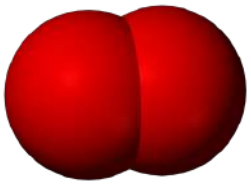
- Respiratory system.
- Skin.
- Mucous membrane.

The Factors That Influence The Casualty's Response To The Agent Are:

- The specific gas (some gases are far more toxic than others).
- Exposure time.
- Concentration / partial pressure of the gas.
- Workload (the higher the workload, the higher the respiratory rate, the higher the absorption of gas).
- General fitness.

Pulmonary Oxygen Toxicity 16.8.1

If O_2 is breathed at a high partial pressure for long periods it becomes toxic, particularly to the lungs. If a very high partial pressure of O_2 is breathed, even for short periods of time, it may rapidly become toxic to the brain (C.N.S. Oxygen Toxicity).



For practical purposes, pulmonary oxygen toxicity will not arise from normal air 'bounce' diving to less than 50 metres.

This is because decompression considerations will limit exposure to O_2 to within safe limits. Diving near the time/depth limits, particularly when such dives are performed repetitively, may provoke pulmonary O_2 toxicity in sensitive individuals.

Patients being treated with fully extended recompression Tables 62 and 63 or Tables 64 and 65 may also experience pulmonary O_2 toxicity, particularly where repeated treatments are applied.

Unit Pulmonary Toxic Dose

Where prolonged exposure to hyperbaric oxygen is necessary, such as during recompression therapy, an estimate of the reduction in vital capacity (VC) can be calculated from the following equation: Where kp is a factor derived from the $p0_2$ using the table below, and "t" the duration of exposure (in minutes).

The "Kp" Table For UPTD Calculation Is: **UPTD = kp X t**

The appropriate kp value is multiplied by the period of time (in minutes) spent at each oxygen partial pressure. These values are then summed to generate the total UPTD value for the exposure. Standard USN Table 6 or RN 62 Treatment Table without extensions are equivalent to 625 UPTD's.

Below is a table, which presents approximate values for expected decrement in vital capacity as a result of various UPTD exposures. It should be recognised that individuals may vary considerably in their response to high partial pressures of oxygen and the UPTD value is useful only as a guide. Generally, a dose of 1425 UPTD is considered to be the upper limit of acceptable exposure.

Normally, a complete recovery from the effects of pulmonary O_2 toxicity can be expected. The time taken for recovery depends largely on the extent of the exposure and where there is a substantial decrement of vital capacity, this may take days or weeks.

UPTD Units	% Decrease in VC
615	2 %
825	4 %
1035	6 %
1230	8 %
1425	10 %
1815	15 %
2190	20 %

$p0_2$(BA)	kp	$p0_2$(BA)	kp	$p0_2$(BA)	kp
0.5	0.00	1.3	1.48	2.1	2.64
0.6	0.26	1.4	1.63	2.2	2.77
0.7	0.47	1.5	1.78	2.3	2.91
0.8	0.65	1.6	1.93	2.4	3.04
0.9	0.83	1.7	2.07	2.5	3.17
1.0	1.00	1.8	2.21	2.6	3.31
1.1	1.16	1.9	2.36	2.7	3.44
1.2	1.32	2.0	2.49	2.8	3.57

Presentation of Pulmonary Oxygen Toxicity

- Tickling sensation in the throat which is worse on inspiration.
- Irritating cough.
- A sensation of substernal burning.
- Coughing becomes uncontrollable.
- Shortness of breath eventually prevents even mild exertion.
- Acute Respiratory Distress Syndrome will present in severe cases.

Management of Pulmonary Oxygen Toxicity

- Reduce the concentration of O_2 in the breathing mixture, (preferably to 0.2 BAR. *$IP0_2$).*
- If substernal burning is present in patients who are responding well to treatment; discontinue oxygen.
- If significant neurological deficit remains and improvement is continuing (or if deterioration occurs when oxygen breathing is interrupted), oxygen breathing should be continued as long as considered beneficial or until pain limits inspiration.
- If oxygen breathing must be continued beyond the period of substernal burning, or if the 4 hour air breaks on long air tables cannot be used because of deterioration upon the discontinuance of oxygen, the oxygen breathing periods should be changed to 20 min on oxygen, followed by 10 min breathing chamber air.

C.N.S. Oxygen Toxicity 16.8.2

There is no fixed O_2 exposure at which toxicity becomes apparent. Instead, susceptibility varies both between individuals and within the same person from day to day. As a consequence, there is no cerebral equivalent of the UPTD.

The onset of C.N.S. Oxygen Toxicity is unlikely in resting individuals at depths of 15m or shallower, and very unlikely at 10m or shallower no matter what the level of activity.

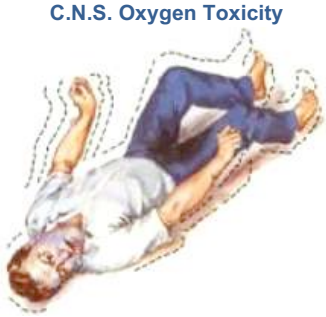
However, patients with severe cerebral decompression illness may be abnormally sensitive to oxygen.

Presentation of C.N.S. Oxygen Toxicity

The classic presentation of CNS Oxygen Toxicity is: V.E.N.T.I.D.C.:

- **V**ision (Tunnel vision) which may include any abnormality, such as tunnel vision (a contraction of the normal field of vision, as if looking through a tube) .
- **E**ars (Ringing/Tinnitus) which may include any abnormality of hearing.
- **N**ausea may be intermittent.
- **T**witching appears first in the lips or other facial muscles but may affect any muscle. (This is the most frequent and clearest warning of oxygen poisoning.
- **I**rritability which includes any change in behaviour, such as anxiety, confusion, and unusual fatigue.
- **D**izzinessan apparent increase in breathing resistance, noticeable clumsiness or lack of co-ordination.
- **C**onvulsions such as generalized clonic tonic seizure.

C.N.S. Oxygen Toxicity



Management of C.N.S. Oxygen Toxicity:

- Reduce the concentration of O_2 in the breathing mixture, (preferably to 0.2 BAR. *$IP0_2$).*
- Conduct primary / secondary survey & record observations.
- Implement Seizure Management.
- Stop decompression. (Refer to company SOP's).
- Contact duty medic / supervisor.
- Prepare to evacuate (as per company S.O.P's).

Convulsions While In Water Diving:

- The diver's depth should be kept as constant as possible until at least the tonic phase of the convulsion ends.
- He should then be returned to the surface.
- Implement airway / breathing management.
- If a diver surfaces because of an oxygen convulsion or must be surfaced to prevent drowning.
  - Observe for pulmonary barotrauma / A.G.E. / D.C.I.
- On reaching safety, remove the breathing apparatus and place the casualty in fresh air to recover.
- Treat for near drowning.

***Note**. Paradoxically, the symptoms of c.n.s. O_2 toxicity may be made transiently worse when the inspired $P0_2$ falls. This is the so-called 'Off Phenomenon'. Consequently the onset of symptoms or signs may be delayed by up to 5 minutes after leaving the water, coming off O_2, or during a decompression stop where the partial pressure of O_2 is reduced.*

Hypoxia 16.8.3

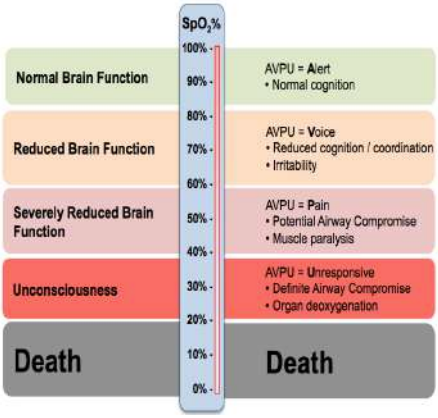
The term 'hypoxia' means 'low oxygen in the blood' (When 0_2, is less than 0.16bar) The term 'Anoxia' means 'an absence oxygen in the blood'.

The Causes Of Hypoxia / Anoxia Are Varied:

- External (reduced / absent O_2 supply in breathing gas).
- Airway impairment.
- Breathing impairment.
- Circulation impairment.
- Respiratory control centre impairment.

Presentation of Hypoxia

- See Hypoxia in Immediate Care Section.
- Cyanosis (Blueing of fingers, earlobes).
- Hyperventilation.
- Increased heart rate.



- Poor co-ordination.
- Sudden collapse.

Presentation of Anoxia

- Profound cyanosis (Blueing of fingers, earlobes).
- Death.

Management of Hypoxia / Anoxia;

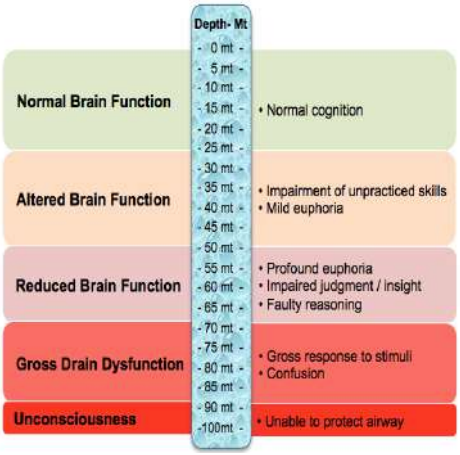
- See Hypoxia in First Aid Section.
- Give high flow O_2 and monitor effects.
- Be prepared to resuscitate.

Nitrogen Narcosis 16.8.4

Narcosis while diving (also known as narced, inert gas narcosis or "the raptures of the deep"), is a reversible alteration in consciousness that occurs while diving at depth.

The Greek word *ναρκωσις* (narcosis) is derived from narke, "temporary decline or loss of senses and movement, numbness".

Narcosis produces a state similar to alcohol intoxication or nitrous oxide inhalation, and can occur during shallow dives, but usually does not become noticeable until greater depths, beyond 30 metres.



Presentation of Nitrogen Narcosis

Responses significantly slow down.
Loosing shortterm memory.
Lack of insight.
Faulty reasoning.
Calculation errors.
Idea fixations.
Increased anxiety, anger or euphoria.
Narrowing of a divers mental focus.

Management of Nitrogen Narcosis

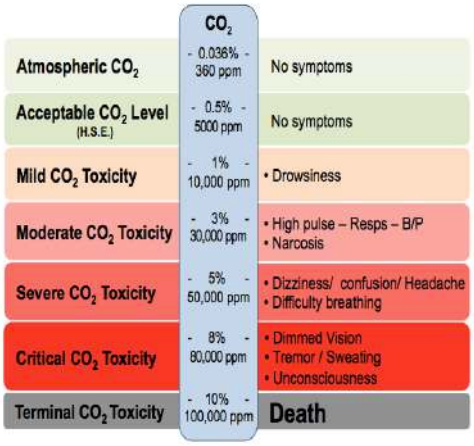
- Decrease depth.
- Change mix (Nitrox?).

Hypercapnia (CO_2 Poisoning) 16.8.5

Also known as hypercarbia, is a condition where there is too much carbon dioxide (CO_2) in the blood. CO_2 is a gaseous product of the body's metabolism and is normally expelled through the lungs. Acceptable levels of CO_2 (As set by H.S.E.) is 5000 ppm or 0.5% in a breathing mix for 8 hrs maximum.

Causes of Hypercapnia;

- Increased workload.
- Pre existing medical condition.
- Failure of CO_2 absorption (closed / semi closed).
  - Channelling.
  - Soda lime canister exhausted.
- Large dead space.
- CO_2 in gas mix.



Presentation of Hypercapnia

- Increase in respiration & pulse rate.
- Headache.
- Sweating.
- Dizziness.
- Nausea.
- Anxiety.
- Unconsciousness.

Management of Hypercapnia

- Manage unconsciousness / reduced consciousness as per Immediate Care.
- Ventilate environment / breathing mix.
- Change soda lime.
- Flush chamber.
- Equalize chamber with entry lock.

Carbon Monoxide Poisoning 16.8.6

Carbon monoxide poisoning occurs after enough inhalation of carbon monoxide (CO).

CO is a colourless, odourless, tasteless, and initially non-irritating toxic gas.

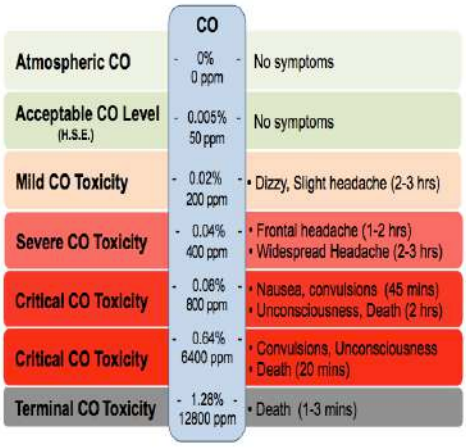
CO is a product of incomplete combustion of organic matter due to insufficient oxygen supply to enable complete oxidation to carbon dioxide (CO_2). It is often produced in domestic or industrial settings by older motor vehicles and other gasoline-powered compressors, heaters, and cooking equipment.

Exposures at 100 ppm or greater can be dangerous to human health. Generally caused in diving by a badly sited compressor intake or from oil breakdown in an overheating compressor.

CO has affinity to Haemoglobin 200 times greater than O_2.

Presentation of Carbon Monoxide Poisoning

- Breathlessness on exertion.
- Lassitude.
- Dizziness / headache.
- Tinnitus.
- Confusion Loss of consciousness.
- Cherry red complexion (unreliable, rare and fatal).



Management of Carbon Monoxide Poisoning

- Change gas supply.
- Jump standby to assist divers ascent.
- Recompression (As per company SOP usually RNT 60 / 61).
- Administrating pure O_2 by BIBS (flushes out CO).
- Instigate reduced consciousness management.

Hydrogen Sulfide Poisoning 16.8.7

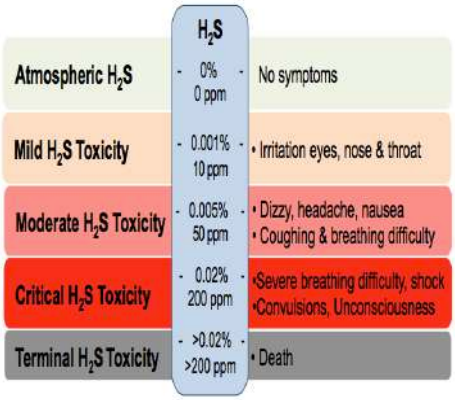
H_2S is an extremely hazardous, toxic compound. It is a colourless, flammable gas that can be identified in relatively low concentrations, by a characteristic *rotten egg* odor. The gas occurs naturally in coal pits, sulfur springs, gas wells, and as a product of decaying sulfur-containing organic matter, particularly under low oxygen conditions. It is therefore commonly encountered in places such as sewers, sewage treatment plants (H_2S is often called *sewer gas*), mines, and the holds of fishing ships.

H_2S occurs naturally in the mud around the well-head of a drill rig. The gas is heavier than air and initially leaves a sulfurous (rotten egg) odour before permanently destroying the sense of smell and therefore becoming tasteless and odourless. Due to the fact the gas is heavier than air / $HE0_2$ it forces the air or gas mix above it leaving any unsuspecting diver to asphyxiate due to lack of oxygen.

When a diver is working on this site they can accumulate this mud on their equipment, bringing it back to the bell/chamber/deck upon their return. This allows the gas to escape into its surrounding environment.

Presentation of Hydrogen Sulphide Poisoning

- Initial smell of rotten eggs.
- Headaches / Vertigo.
- Loss of smell.
- Cough / Haemoptysis.
- Confusion.
- Nausea and vomiting.
- Asphyxiation.
- Possible loss of consciousness.
- Seizure.
- Death.



Management of Hydrogen Sulfide Poisoning

- If presence of H_2S is suspected then evacuate to a high point until the area is confirmed clear.
- Administer pure O_2 (flushes out H_2S).
- Instigate reduced consciousness management.

Hydrocarbon Poisoning 16.8.8

Within the commercial oil industry there is often an associated risk of hydrocarbon vapour contamination.

There is likelihood for contamination of the bell atmosphere from vapourised contaminants carried on dive suits and umbilical's.

Potentially fatal, levels of hydrocarbons can accumulate in the enclosed environment of a diving bell.

Hydrocarbon vapour has a profoundly sedative quality, so even if fatal levels are not reached immediately, divers may be incapacitated before they can initiate environmental flushing measures.

Presentation of Hydrocarbon Toxicity

Hydrocarbon vapours in the bell and can reach anaesthetic concentrations within minutes.

- Divers can suffer the effects within a few breaths.
- Even before unconsciousness, the ability to react normally becomes impaired:
  - 52% of the anaesthetic level of cyclo-hexane causes convulsions.
  - 44% of the anaesthetic level of benzene causes uncontrolled jerking of limbs.
  - 33% of the anaesthetic level of toluene leads to hyperactivity.
  - 13% of the anaesthetic level of xylene causes tremors, which could impair actions.

Bell Vapour Analysis

Management of Hydrocarbon Poisoning

- Ensure hydrocarbon analysis equipment is functioning & divers are trained in its use.
- Immidiatly don BIBS & flush compartment on contamination.
- Closley observe & manage casualtys who have sucomed to the effects of hydrocarbon exposure.
- Decontaminate bell (as per company SOP's).

DANGEROUS MARINE ANIMALS 16.9

Venomous / Poisonous Marine Inhabitants 16.9.1

Poisons are substances that are harmful when a sufficient quantity is absorbed by an organism.

Venom is a general term referring to a biotoxic agent. A biotoxin is a biologically produced peptide or protein, which can interfere with enzyme or cellular receptors:

Types Of Biotoxins Include:

- Haemotoxins.(destruction of red blood cells & interference with blood clotting cascade).
- Cardiotoxins (Toxic to the heart. These toxins may cause the heart to beat irregularly or stop beating, causing death).
- Cytotoxins. (Toxic to cells).
- Neurotoxins. (Affects the nervous system / inhibits neuron cellular processes).

Venomous Fish (excluding Stonefish, Zebrafish, Scorpionfish) 16.9.2

Identification of a fish following a sting is not always possible; however, symptoms and effects of venom do not vary greatly.

Venomous fish are rarely aggressive and usually contact is made by accident. Dead fish spines remain toxic. Venom is generally denatured in heat and may be neutralized by hot water.

Prevention

Avoid handling suspected venomous fish. Venomous fish are often found in holes or crevices or lying well camouflaged on rocky bottoms. Divers should be alert for their presence and should take care to avoid them.

Presentation of Venomous Fish Envenomation;

- Severe pain (may seem disproportionately high to apparent severity of the injury).
- Numbness / hypersensitivity around the wound.
- The wound site may become cyanotic with tissue becoming pale and swollen.

General Symptoms May Include:

- Nausea / vomiting.
- Sweating / mild fever.
- Anaphylaxis.
- Respiratory distress and collapse.

Lion Fish

Management Of Venomous Fish Envenomation

- Get victim out of water; watch for fainting.
- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Implement shock (anaphylactic) management. (O_2, I.V.I. Etc).
- Monitor and assess casualty until help arrives.
- Manage any wounds:
  - Wash wound with salt water or sterile saline solution.
  - Suction is **not** effective to remove this toxin.
  - Soak wound in hot water for 30 to 90 minutes (heat may break down the venom. The water should be as hot as the victim can tolerate but not hotter than 50°C).

Mandarin Fish

- Use hot compresses if the wound is on the face.
- Clean and debride wound. Spines and sheath frequently remain. Be sure to remove all of the sheath as it may continue to release venom.
- Use an antiseptic or antibiotic ointment and sterile dressing.
- Restrict movement of the extremity with immobilising splints.

- Manage pain with analgesia as prescribed. (Infiltration of the wound with 0.5% to 2.0% xylocaine **without** adrenaline is helpful).
- Administer tetanus prophylaxis as perscribed.
- Review by duty medic.
- Prepare to evacuate (as per company S.O.P's).

Highly Toxic Fish (Stonefish, Zebrafish, Scorpionfish) 16.9.3

Stings by stonefish, zebrafish and scorpionfish have been known to cause fatalities. While many similarities exist between these fish and the venomous fish of the previous section, a separate section has been included because of the greater toxicity of their venom and the availability of antivenom.

The antivenin is specific for the stonefish but may have some beneficial effects against the scorpionfish and zebrafish.

These fish are widely distributed in temperate and tropical seas and in some arctic waters. They are shallow water bottom dwellers. Stonefish and scorpionfish are flattened vertically, dark and mottled. Zebrafish are ornate and feathery in appearance with alternating patches of dark and light colour.

Scorpion Fish

Presentation of Highly Toxic Fish Envenomation;

- Exceptional pain (disproportionately high to apparent severity of the injury and may last for days).
- The wound site may become cyanotic with tissue becoming pale and swollen.

Stone Fish

General Symptoms May Include:

- Nausea / vomiting.
- Sweating / mild fever.
- Anaphylactic shock.
- The venom is an unstable protein, which acts as a myotoxin on skeletal, involuntary and cardiac muscle.

  This may result in:
  - Muscular paralysis.
  - Respiratory depression.
  - Peripheral vasodilatation.
  - Shock.
  - Cardiac dysrhthmias.
  - Cardiac arrest.

Zebra Fish

Management of Highly Toxic Fish Envenomation

- Implement venomous fish management.
- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Observe the patient carefully for the possible development of life-threatening complications.
- **Give Antivenin as prescribed.**
- Institute tetanus prophylaxis, analgesic therapy and antibiotics for other fish stings.

Sea Urchins 16.9.4

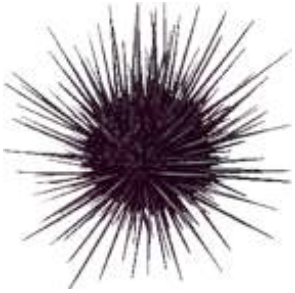
There are various species of sea urchins with widespread distribution. Each species has a radial shape and long spines. Penetration of the sea urchin can cause intense local pain due to a venom in the spine or from another type of stinging organ called globiferous pedicellariae.

Prevention

Avoid contact with sea urchins. Even the short spined sea urchin can inflict its venom via the pedicellariae stinging organs. Protective footwear and gloves are recommended. Spines can penetrate wetsuits and booties.

Presentation of Sea Urchin Envenomation;

Sea Urchin



- Intense pain at site of sting.
- Numbness / generalised weakness / paraesthesia.
- Nausea & vomiting.
- Cardiac dysrhythmias.

Management of Sea Urchin Envenomation;

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Manage bleeding.
- Implement Shock Management. (O_2, I.V.I. Etc).
- Manage anaphylaxis / allergic reaction.
- There are **no specific antivenins available**.
- Manage any wounds (see wound management section).
  - Remove spine fragments gently, being careful not to break them into fragments that remain in the wound.
  - Bathe the wound in vinegar or isopropyl alcohol.
  - Soaking the injured extremity in hot water up to 50°C may help (Caution should be used to prevent scalding).
  - Clean and debride the wound. Topical antibiotic ointment should be used to prevent infection.
  - Take culture swab and administer antibiotics for secondary infections if prescribed.
  - Remove as much of the spine as possible (Some small fragments may be absorbed by the body).
  - Administer tetanus prophylaxis as appropriate.
  - Get medical attention for deep wounds.
- Surgical removal may be necessary. This may be required when spines are near nerves and joints.
- X-rays may be required to locate these spines.
- Spines can form granulomas months later and may even migrate to other sites.

Sea Sponges 16.9.5

Sponges are composed of minute multi-cellular animals with spicules of silica or calcium carbonate embedded in a fibrous skeleton. Exposure of skin to the chemical irritants on the surface of certain sponges or exposure to the minute sharp spicules can cause painful skin condition called dermatitis.

Prevention

Avoid contact with sponges and wear gloves when handling live sponges.

Sea Sponge

Presentation of Sea Urchin Envenomation;

- Relative pain at site of contamination.
- Localised inflammation.

Management of Sponge Contact

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor. (Urgently).
- Implement Shock Management. (O_2, I.V.I. Etc). As appropriate.
- Adhesive or duct tape can effectively remove the sponge spicules.
- Vinegar (or 3% -10% acetic acid) can be topically applied (sponges may be secondarily inhabited by stinging coelenterates).
- Antihistamine and topical steroid creams may be applied to reduce the early inflammatory reaction.
- Antibiotic ointment is effective in reducing the chance of a secondary infection.
- Prepare to evacuate (as per company S.O.P's).

Venomous Immediate Action Summary

Organism	Detoxification	Treatment
Stingray Lionfish Scorpion Fish Catfish	Submerge injury in hot water for 30-90 min.	• Irrigation with normal saline. • Exploration and debridement. • Antibiotics and analgesics. • Anti-tetanus agent. • Observe to rule out systemic envenomation. • Compression bandaging. (With caution)
Stonefish	Submerge injury in hot water for 30-90 min.	• Same as outlined for stingray. • Stonefish antivenin for systemic reactions.
Sea Urchin Starfish Sponges	• Submerge injury in hot water for 30-90 min. Removal of any spines or pedicellariae.	• Same as outlined for stingray. • Exploration and removal of any spines.
Fireworms	• Irrigate with seawater (not fresh water). • Topical 5% acetic acid / Ammonia. • Use forceps to remove spines (Very Tiny).	Same as outlined for stingray.

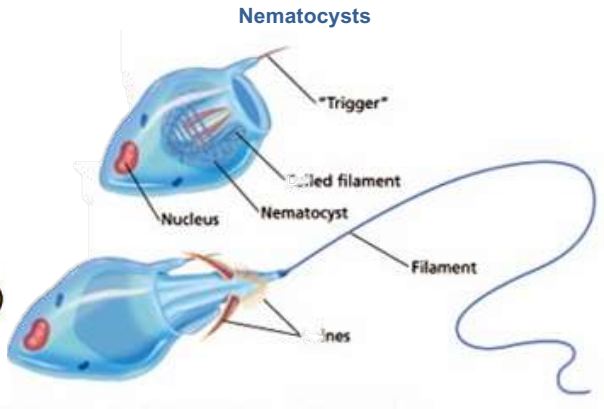
Stinging Cells (Coelenterates) 16.9.6

Coelenterates contain thousands of specialized stinging cells (nematocysts) capable of penetrating the skin with harpoon-like threads and injecting venom upon contact.

The potency of venom varies from species to species.

Coelenterates Are Divided Into Two Groups:

- Ctenophora
  - Comb Jellyfish.
- Cnidaria
  - True Jellyfish.
  - Sea anemones.
  - Corals.



Jellyfish

Hazardous Types Of Coelenterates Include:

- Portuguese man-of-war.
- Box jellyfish.
- Lion's mane jellyfish
- Irukanjis.
- Sea nettle / sea blubber.
- Fire Coral
- Sea anemone.
- Bubble or Grape Coral.

Jellyfish vary widely in colour (blue, green, pink, red, brown) or may be transparent. They appear to be balloon-like floats with tentacles dangling down into the water. The most common stinging injury is the jellyfish sting. Jellyfish can come into direct contact with a diver in virtually any oceanic region, worldwide.

When this happens, the diver is exposed to literally thousands of minute stinging organs in the tentacles called nematocysts. Most jellyfish stings result only in painful local skin irritation.

Deaths from Portuguese man-of-war stings have also been reported.

Prevention

Do not handle jellyfish. Beached or apparently dead specimens may still be able to sting. Towels or clothing contaminated with the stinging nematocysts may even cause stinging months later.

Avoidance of Tentacles

In some species of jellyfish, tentacles may trail for great distances horizontally or vertically in the water and are not easily seen. Divers should avoid close proximity to jellyfish to avoid contacting their tentacles, especially when near the surface.

Portuguese Man Of War

Presentation of Sea Nematocyst Sting;

- The box jellyfish and Portuguese man-of-war are the most dangerous types.
- Localised severe pain and inflammation.
- The box jellyfish (found in the Indo-Pacific) can induce death within 10 minutes:
  - Respiratory failure
  - Cardiovascular collapse.
  - Muscular paralysis.

Protection Against Jellyfish

Wet suits, body shells, or protective clothing should be worn when diving in waters where jellyfish are abundant. Petroleum jelly applied to exposed skin (e.g., around the mouth) helps to prevent stinging.

Management of Jellyfish Stings

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Implement Shock Management. (O_2, I.V.I. etc). as appropriate. (Anaphylaxis is a relative risk).
- Antivenin **is available** to neutralize the effects of the box jellyfish (Chironex fleckeri).
- Without rubbing, gently remove any remaining tentacles using a towel or clothing.
- For preventing any further discharge of the stinging nematocysts, use vinegar (3 -10% solution of acetic acid).
- Picric acid, human urine, and fresh water also have been found to either be ineffective or even to discharge nematocysts and should not be used.
- Reassess regularly. Refer to Duty Medic if no improvement.
- Symptomatic treatment can include topical steroid therapy, anaesthetic ointment antihistamine lotion, systemic antihistamines or analgesics.

Do not use alcohol or preparations containing alcohol. Methylated spirits or methanol, 100 percent alcohol and alcohol plus seawater mixtures have all been demonstrated to cause a massive discharge of the nematocysts. In addition, these compounds may also worsen the skin inflammatory reaction.

Coral

Coral, a porous, rock-like formation, is found in tropical and subtropical waters. Coral is extremely sharp and the most delicate coral is often the most dangerous because of their razor-sharp edges.

Coral cuts, while usually superficial, take a long time to heal and can cause temporary disability.

Prevention

Extreme care should be used when working near coral. Often coral is located in a reef formation subjected to heavy surface water action, surface current, and bottom current. Surge also develops in reef areas. For this reason, it is easy for the unknowing diver to be swept or tumbled across coral with serious consequences. Be prepared.

Coral should not be handled with bare hands. Feet should be protected with booties, coral shoes or tennis shoes. Wet suits and protective clothing, especially gloves (neoprene or heavy work gloves) should be worn when near coral.

Playthoa Coral

Presentation of Coral Stings:

Some varieties of coral can actually sting a diver since coral is a coelenterate like jellyfish.

- Localised severe pain and inflammation.
- The slime of this coral may cause a serious skin reaction (dermatitis) and may be fatal if exposed to an open wound.
- Secondary infections often occur and may be recognised by a red and tender area surrounding the wound.
- Some of the soft coral of the genus *playthoa* contains a deadly poison (within the body - not in the stinging nematocysts).

Management of Coral Stings:

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Manage bleeding.
- Implement shock management. (O_2 , I.V.I. Etc).
- Manage any wounds (see wound management section).
  - Clean wound with saline, debride the wound removing all foreign particles.
  - Cover with a clean dressing.
- Monitor and assess casualty until help arrives.
- Administer tetanus prophylaxis as appropriate.
- Topical antibiotic / steroid therapy, systemic antihistamines and analgesics.
- Systemic steroids may be needed to manage the inflammatory reaction due to trauma and dermatitis.
- Prepare to evacuate (as per company S.O.P's).

Anti-histamine Cream

Stinging Cell Immediate Action Summary		
Organism	**Detoxification**	**Treatment**
Fire Coral Anemones	• Irrigate with seawater (not fresh water). • Topical 5% acetic acid / Ammonia. • Shave affected area.	• Irrigation with normal saline. • Exploration and debridement. • Antibiotics and analgesics. • Anti-tetanus agent. • Observe to rule out systemic envenomation. • Compression bandaging. • Topical corticosteroid cream for dermatitis.
Portuguese man-of-war Sea Nettles	• Irrigate with seawater (not fresh water). • Topical 5% acetic acid / Ammonia. • Shave affected area. • Use forceps or gloves to remove tentacles.	• Same as outlined for Fire Coral. • Close observation. • Hospitalise if systemic symptoms.
Box Jellyfish	• Irrigate with seawater (not fresh water). • Topical 5% acetic acid / Ammonia. • Shave affected area. • Use forceps or gloves to remove tentacles.	• Same as for Portuguese man-of-war. • Give Chironex antivenin. • Close observation. • Hospitalise if systemic symptoms.
Irukanji	• Irrigate with seawater (not fresh water). • Use forceps or gloves to remove tendrils.	• Same as for Portuguese man-of-war. • Intravenous Magnesium. • Strong Analgesia.

Tetrodotoxin 16.9.7

Tetrodotoxin, also referred to as "zombie powder" by those who practice voodoo. Tetrodotoxin, frequently abbreviated as TTX, is a potent neurotoxin with no known antidote.

Tetrodotoxin blocks action potentials in nerves, essentially preventing any affected nerve cells from firing by blocking the channels used in the process.

Puffer Fish

The Toxin Is Present In:

- Blue Ringed Octopus (Produced via bacteria).
- Cone Shell.
- Porcupinefish.
- Puffer Fish (ingested from the gut).

Blue Ringed Octopus

The octopus inhabits tropical and temperate oceans. Species vary depending on region. It has a large sac surrounded by 8-10 tentacles. The head sac is large with well-developed eyes and horny jaws.

The octopus will hide in caves, crevices and shells. It possesses a well-developed venom apparatus in its salivary glands and stings by biting.

Blue Ringed Octopus

The blue-ringed octopus common in Australian and Indo-Pacific waters may inflict fatal bites. The venom of the blue-ringed octopus is a neuromuscular blocker called tetrodotoxin.

Prevention

Extreme care should be used when reaching into caves and crevices. Regardless of size, an octopus should be handled carefully with gloves. It is ill advised to spear an octopus, especially the large octopuses found off the coast of Northwestern United States, due to the risk of being entangled by the octopus' tentacles. If killing an octopus becomes necessary, stabbing it between the eyes is recommended.

Presentation of Blue Ringed Octopus Bite:

A victim may not feel a bite at all. The neurotoxin may immediately paralyze the pain receptors.

- Octopus bites consist of two small punctures.
- A burning or tingling sensation results and may soon spread.
- Swelling, redness and inflammation are common.
- Visual disturbances .
- Muscular paralysis.
- Vomiting.
- Respiratory difficulty / collapse.
- Cardiovascular collapse.
- Bleeding may be severe and the clotting ability of the blood is often retarded by the action of an anticoagulant in the venom.

Management of Octopus Envenomation

Blue-ringed venom is **heat stable** and acts as a neurotoxin and neuromuscular blocking agent.

Venom **is not** affected by hot water therapy.

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Manage bleeding.
- Implement Shock Management. (O_2 , I.V.I. Etc).
- Manage any wounds (see wound management section).
  - Clean and debride the wound and cover with a clean dressing.
  - Apply direct pressure with a pressure bandage and immobilise the extremity in a position that is lower than the heart using splints and elastic bandages.
- Constantly monitor & resuscitate as appropriate.
- **No antivenin is available.**
- Manage paralytic, cardiovascular and respiratory complications.
- Respiratory arrest is common and intubation with mechanical ventilation may be required.
- Duration of paralysis is between 4 and 12 hours.
- Administer tetanus prophylaxis as appropriate.

Cone Shells

The cone shell is widely distributed in all regions and is usually found under rock, coral or crawling along sand.

The shell is most often symmetrical in a spiral coil, colourful, with a distinct head, one to two pairs of tentacles, two eyes, and a large flattened foot on the body.

Cone Shell

A cone shell sting should be considered as severe as a poisonous snakebite. It has a highly developed venom apparatus: venom is contained in darts inside the proboscis, which extrudes from the shell.

Prevention

Avoid handling cone shells. Venom can be injected through clothing and gloves.

Presentation of Cone Shell Envenomation:

- Severe stinging or burning sensation at the site of the puncture.
- Symptoms develop within minutes of the sting and effects can last up to 24 hours.
- Numbness and tingling at puncture site:
  - Numbness and tingling spreading to the rest of the body (mouth and lips severely affected).
- Muscular paralysis - difficulty with swallowing and speech.
- Visual disturbances.
- Respiratory distress may occur due to neuromuscular block.

Management of Cone Shell Envenomation;

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor. **Urgently**.
- Implement shock management. (O_2, I.V.I. etc) as appropriate.
- Direct pressure with a pressure bandage and immobilisation in a position lower than the level of the heart using splints and elastic bandages is recommended.
- Reassess Regularly. (Use neuro exam including AVPU /GCS)
  - If the casualty conscious level is severely reduced (G.C.S. ≤ 8, Only responding to Pain in AVPU). Protect airway with appropriate device* (jaw thrust, Oro-pharangeal Airway, iGEL Endo-tracheal intubation & ventilate).
- **No antivenin is available.**
- Manage pain: (Local anaesthetic with no adrenaline may be injected into the site of the wound if pain is severe).
- Administer tetanus prophylaxis as appropriate.
- Prepare to evacuate **Urgently** (As per company S.O.P's).

Tetrodotoxin Immediate Action Summary

Organism	Detoxification	Treatment
Puffer Fish	• Toxin only present inside of fishes gut. • Activated charcoal orally if animal ingested.	• Close observation • Airway support. • Renal haemofiltration. • Shock management.
Cone Shell	• Submerge injury in hot water for 30-90 min. • Use forceps to remove spine.	• Airway support. • Irrigation with normal saline. • Exploration and debridement. • Antibiotics and analgesics. • Anti-tetanus agent. • Observe to rule out systemic envenomation. • Compression bandaging. • Topical corticosteroid cream for dermatitis.
Blue Ringed Octopus	• Irrigate with seawater (not fresh water).	• Same as outlined for cone shell. • Do not elevate limb above heart level. • Airway intubation is commonly needed. • Advanced cardiovascular support.

Sea Snakes 16.9.8

The sea snake is an air-breathing reptile, which has adapted to its aquatic environment by developing a paddle tail.

It injects a poison that has 2 to 10 times the toxicity of cobra venom. The bites usually appear as 4 puncture marks but may range from 1 to 20 punctures. Teeth may remain in the wound. The neurotoxin poison is a **heat stable** non-enzymatic protein; hence, sea snake bites should not be immersed in hot water as with venomous fish stings.

Sea snakes inhabit the Indo-Pacific area and the Red Sea, and have been seen 150 miles from land.

The most dangerous areas in which to swim are river mouths where sea snakes are more numerous and the water more turbid. The sea snake is a true snake, usually three to four feet in length but may reach nine feet. It is generally banded. The sea snake is curious and is often attracted. Usually it is not aggressive except during its mating season.

Sea Snake

Due to its small jaws, bites often do not result in envenomation.

Prevention

Wet suits or protective clothing, especially gloves may provide substantial protection against bites and should be worn when diving in waters where sea snakes are abundant. Also, shoes should be worn when walking where sea snakes are known to exist, including in the vicinity of fishing operations.

Do not handle sea snakes. Bites often occur on the hands of fishermen attempting to remove snakes for nets.

Presentation of a Sea Snake Envenomation;

- Bites are usually painless (as with many neurotoxins).
- The bite appears as 4 puncture marks. (Teeth may remain in the wound).
- Early symptoms include headache, a thick-feeling tongue, thirst, sweating, and vomiting.

- Symptoms that can occur after 10 minutes to several hours.
- Generalized aching, stiffness, and tenderness of muscles.
- Progressive flaccid paralysis (including respiratory system).
- After 3–8 hours, myoglobin presents (urine becomes 'coke cola' coloured).
- After 6 to 12 hours, severe hyperkalemia.

Management of Sea Snake Envenomation

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor (Urgently).
- Implement Shock Management. (O_2, I.V.I. Etc) as appropriate. Anaphylaxis is common.
- Apply direct pressure using a compression bandage and immobilise the extremity in the dependent position with splints and elastic bandages (This prevents spreading of the neurotoxin through the lymphatic circulation).
- Incise and apply suction (if able to perform);
  - The cut should be small (one centimetre), linear and penetrate no deeper than the subcutaneous tissue.
  - The suction should only be performed if it is possible to do so within two minutes of the bites.
  - The incision and suction by inexperienced personnel has resulted in inadvertent disruption of nerves, tendons and blood vessels.
- Reassess regularly. (Use neuro exam including AVPU /GCS) If the casualty conscious level is severely reduced (G.C.S. ≤ 8, Only responding to pain in AVPU). Protect airway with appropriate device* (jaw thrust, oro-pharyngeal airway, iGEL Endo-tracheal intubation & ventilate).
- Implement Shock Management. (O_2, I.V.I. Etc).
- Manage pain: (Local anaesthetic with no adrenaline may be injected into the site of the wound if pain is severe).
- Treat Rhabdomyolysis.
- If symptoms of envenomation occur within one hour, antivenin should be administered as soon as possible.
- Administer tetanus prophylaxis as appropriate.
- Prepare to evacuate **Urgently** (as per company S.O.P's).

The venom is a **heat stable protein**, which blocks neuromuscular transmission. Myonecrosis with resultant myoglobinuria and renal damage are often seen. Hypotension may develop

Sea Snake Immediate Action Summary		
Organism	**Detoxification**	**Treatment**
Sea Snake	• Irrigate with seawater (not fresh water). • Use forceps to remove fangs.	• Airway support. • Compression bandaging. • Irrigation with normal saline. • Exploration and debridement. • Specific antivenin. • Antibiotics and analgesics. • Anti-tetanus agent. • Observe to rule out systemic envenomation. • Topical corticosteroid cream for dermatitis.

Coral Cuts 16.9.9

Coral frequently causes lacerations, and abrasions to inexperienced divers. These injuries may initially appear minor in nature, but because of foreign material, such as pieces of coral, nematocysts, infected slime etc., they frequently become inflamed and infected.

Coral may also harbour stinging nematocysts.

Secondary bacterial infection is common after penetrating or abrasive marine injuries.

The Organisms Include:

- Staphylococcus aureus (the most common source resulting in cellulitis).
- Vibro vulnificus (a gram –ve bacteria specific to the marine environment).
- Tetanus is also a relative risk.

Prevention

Coral cuts can be avoided by the use of protective clothing, gloves, swim fins with heel cover and active treatment of minor abrasions.

Presentation of Coral Cuts;

- The laceration, usually on the hand or foot, causes little trouble at the time of injury.
- Some hours later there may be a 'smarting' sensation, and a mild inflammatory reaction around the cut (This may be due to the presence of discharging nematocyst).
- Over 1 - 2 days, local swelling, erythema, and tenderness develop around the site (Usually this abates in 3 to 7 days).
- Fever, chills, arthralgia, malaise, (systemic effects of a severe bacterial infection).
- Occasionally an abscess, or ulcer will form and discharge pus.
  - Celluitis, and/or lymphadenitis may accompany the acute stage.
  - This may become chronic with osteomyelitis a possibility.

- Healing may take months to years if complications ensue.

Management of Coral Cuts;

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Manage bleeding.
- Implement Shock Management. (O_2, I.V.I. etc).
- Manage any wounds (see wound management section).
  - This involves early antisepsis, and total removal of foreign material (e.g. with soft brush).
  - The wound should be dressed with antibiotic powder, or ointment.
  - Swab should be taken for culture, and sensitivity.
- Tetanus prophylaxis may be advisable.
- Cellulitis, lymphangitis etc. indicates the need for a broad-spectrum systemic antibiotic (e.g. ampicillin, tetracycline).
- Bed rest, elevation of the affected limb, and other general supportive measures.

Marine Attacks 16.9.10

Attacks by marine animal are actually **very** rare.

Orka (Killer Whale)

Main Dangers To Diver:

- Morays (and Conger).
- Octopi.
- Aggressive fish (Barracuda, Triggerfish Jacks).
- Marine mammals (seals, sea lions, Orka, dolphins).

Marine Attack Causes Are Varied:

- Misidentification of diver.
- Defensive reaction.
- Occur when feeding fish or animals.
- Probability of attack overestimated.
- Blood loss in water can be dramatic.

Moray Eels

While some temperate zone species of the moray eel are known, it primarily inhabits tropical and subtropical waters. It is a bottom dweller and is commonly found in holes and crevices or under rocks and coral.

It is snake-like in both appearance and movement and has tough, leathery skin. It can grow to a length of 10 feet and has prominent teeth.

A moray eel is extremely territorial and attacks frequently result from reaching into a crevice or hole occupied by the eel.

Moray Eel

Prevention

- Extreme care should be used when reaching into holes or crevices.
- Avoid provoking or attempting to dislodge an eel from its hole.

Presentation of Moray Eel Bites;

- It is a powerful and vicious biter and may be difficult to dislodge after a bite is initiated.
- Bites may vary from multiple small puncture wounds to the tearing, jagged type with profuse bleeding if there has been a struggle.

Management of Moray Eel Attacks

- Implement shark attack management.
- A medic should evaluate severe hand injuries immediately.
- Implement bleeding / wound management.
- Tetanus prophylaxis may be advisable.
- Antibiotic therapy should be instituted early.
- Immediate specialized care by a hand surgeon may be necessary for tendon and nerve repair of the hand to prevent permanent damage and loss of function of the hand.

Mild envenomation may occur from a toxin that is released from the palatine mucosa in the mouth of certain moray eels. The nature of this toxin is not known. Treatment is supportive.

Shark Attack

Shark attacks on humans are infrequent. Since 1965, the annual recorded number of shark attacks is only 40 to 100 worldwide.

Shark Attacks Are Rare:

- 2,251 attacks worldwide since 1580 (with 464 attacks being fatal.)
- Chance of getting attacked is 1 in 11.5 million. (obviously higher if your career is in the water).
- Chance of getting killed by a shark is less than 1 in 264 million.

Tiger Shark

These attacks are unpredictable and injuries may result not only from bites, but also by coming in contact with the shark's skin.

Sharkskin is covered with very sharp dentine appendages, called denticles, which are reinforced with tooth-like centres.

Contact with sharkskin can lead to wide abrasions and heavy bleeding.

Shark Pre-Attack Behaviour

Pre-attack behaviour by most sharks is somewhat predictable.

A shark preparing to attack swims with an exaggerated motion, its pectoral fins pointing down in contrast to the usual flared out position, and it swims in circles of decreasing radius around the prey.

An attack may be heralded by unexpected acceleration or other marked change in behaviour, posture, or swim patterns. Should surrounding schools of fish become unexplainably agitated, sharks may be in the area.

Sharks are much faster and more powerful than any swimmer. **All sharks** must be treated with extreme respect and caution.

There Are Different Modes Of Shark Attacks:

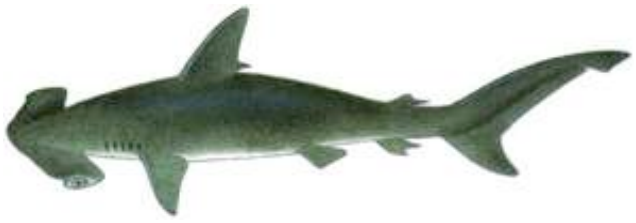
- Indifference (rare).
- Approach with swift visual inspection (without follow-up).
- Approach with surveillance circling (without follow up, contact or attack).
- Approach with brush-past (without follow-up) **(wounding possible).**
- Charge with collision (generally upwards trajectory) **(wounding possible).**
- Charge with single or double investigative bite without tearing.
- Charge with biting and removal of flesh **(death in 45% of cases).**
- Multiple feeding-frenzy charge **(death in 100% of cases).**

Great White Shark

Management of Shark Attacks;

- Conduct primary / secondary survey & record observations.
- Contact duty medic / supervisor.
- Manage bleeding / amputation / crush injury.
- Manage any wounds (see wound management section).
  - Culture infected wounds for both aerobes and anaerobes (Clostridium and Vibrio contamination are common).
  - Give antibiotics as prescribed.
  - Administer tetanus prophylaxis as per duty medic's instructions.
- Implement shock management. (O_2, I.V.I. Etc).
- Prepare to evacuate (as per company S.O.P's).
- Monitor and assess casualty until help arrives.

Hammer Head Shark



FIRST AID KITS 17

The First Aid requirements for seaborne craft is contained in the MCA document MSN 1768 (M+F).
It separates the first aid requirements of craft into three categories:

Category A

Seagoing or sea-fishing vessels with no limitation on length of trips.

Category B

Seagoing or sea-fishing vessels making trips of less than 150 nautical miles from the nearest port with adequate medical equipment. This category is extended to seagoing or sea-fishing vessels which make trips of less than 175 nautical miles from the nearest port that has adequate medical equipment and which remain continuously within range of helicopter rescue services.

Category C

Harbour vessels, boats and craft staying very close to shore or with no cabin accommodation other than a wheelhouse. Lifeboats and life-rafts are also required to carry Category C stores. The UK interprets the phrase **"very close to shore"** as meaning that a vessel operating more than 60 nautical miles out to sea would not be operating very close to shore.

Your First Aid Kit is essentially your 'tools of the trade'. First Aid kits should be easily accessible, preferably placed near to hand and clearly identified. The container should protect the contents from dust and damp.

Other items that may need to be considered are such things as blankets to protect casualties from the elements. As a rule, a First Aid kit should be tailored to the environment in which it is used.

If the kit is primarily being used in a galley, then a burns component should be added, or in an engine room place a trauma dressing & eye wash kit. A risk assessment should be conducted & the actual / potential dangers identified.

Cat C First Aid Kit (Inshore Limits MSN 1768) 17.1

Category	Items	Qty
Dressings	Adhesive Elastic Dressing (7.5cm x 4cm / Sterile)	1
	Medium Standard Dressing (N⁰ 9)	2
	Large Standard Dressing (N⁰ 15)	2
	Extra Large Standard Dressing (N⁰ 3)	1
	Triangular Bandage (90cm x 90cm x 127cm)	4
	Paraffin Gauze Dressing (10cm x 10cm)	10
	Gauze Swabs (7.5cm x 7.5cm / Sterile)	5
	Wash-proof Plasters (Assorted / Sterile)	20
Hygiene	Adhesive Skin Closures	6
	Antiseptic Cleansing wipes	10
	Pair of medical gloves	5
Sundries	Stainless Steel Scissors 5"	1
	Safety Pins (Rust-less)	6
	Burn Bag	1
	Resuscitation Face Mask	1
	First Aid Instructions (Waterproof)	1
Medication	Loperamide (2mg Caps / For Diarroea)	20
	Hyocine Hydrobromide (0.3mg Tabs / Sea-Sickness)	60
	Paracetamol (500mg Tabs / Pain-killer)	65
	Ibuprofen (400mg Tabs / Pain-Killer)	50
	Glyceryl Tri-Nitrate (Spray / Angina)	1
	Centrimide (50g Cream / Topical Antiseptic)	1

Vessel First Aid Kit (Offshore Limits <150 NM MSN 1768 Cat B) 17.2

Medication

Category	Items	Qty
Cardio-vascular	•Adrenaline / Epinephrine injection (BP 0.5ml – adrenaline acid tartrate injection 1.0mg in 1ml (1 in 1000)) and / or	5
	•Epi-pen (Adrenaline 0.3mg)	5
Anti-angina Preparations	•Glyceryl Trinitrate Spray (400 micrograms / metered 200 dose)	1
	•Trans-dermal Patches (5mg)	2
Diuretics	•Frusemide / Furosemide (40mg tablets)	28
Anti-haemorrhage if there are women of child bearing age working on board.	•Phytomenadione (Vitamin K1) paediatric injection (0.2ml ampoule)	1
	•Ergometrine 500mcg (Oxytocin 5 units (1ml ampoule) (Syntometrine)	1
Anti-emetics	•Prochlorperazine maleate (3mg buccal tablets)	50
	•Hyoscine hydrobromide (0.3mg tablets) or	60
	•Cinnarizine (15mg tablets)	60
Analgesics / Anti-Inflammatory	•Paracetamol (500mg tablets)	50
	•Ibuprofen (400mg tablets)	50
Strong Analgesics	•Codeine Phosphate (30mg tablets)	28
	•Morphine Sulphate (10mg in 1ml injection (1ml ampoule) or	10
	•Nalbuphine (10mg in 1ml injection)	10
Spasmolytics	•Hyoscine butylbromide (10mg tablets)	56
Neuroleptics	•Chlorpromazine hydrochloride (25mg tablets)	28
Anti-epileptics	•Diazepam rectal dispenser (10mg in 2.5ml)	5
H1 Anti-histamines	•Cetrirzine (10mg tablets)	30
Glucocorticoids	•Hydrocortisone (100mg in 1ml injection)	1
	•Prednisolone (5mg tablets)	28
Anti-tussives	•Proprietary cough mixture	1
Antibiotics	•Benzyl-penicillin-sodium (600mg injection)	2
	•Ciprofloxacin (as hydrochloride) 500mg tablets)	10
	•Erythromycin (250mg tablets)	28
	•Trimethoprim (200mg tablets)	14
	•Metronidazole (500mg or 400mg tablets)	21
Anti-parasitics	•Mebendazole (100mg tablets)	6
Anti-tetanus	•Tetanus Vaccine (0.5ml ampoule) or Tetanus & Diphtheria Vaccine)	1

Creams

Category	Items	Qty
WHO Generic Formula	•Oral Rehydration Salts (Formula A, Sodium chloride & dextrose salts sachets. Or Proprietary equivalent e.g. Dioralyte)	20
Antiseptic Wipes	•Wipes (containing 0.015% w/v chlorhexidine and 0.15% w/v cetrimide)	1box
Antibiotic Ointments	•Neomycin / Bacitracin (cream 15g tube)	1
Anti-mycotic creams	•Benzoic ointment BP (50mg (benzoic acid 6%; salicylic acid 3%, in emulsifying ointment 15g Miconazole nitrate 2% topical cream 30g)	1
	•Clotrimazole 500mg (pressary (if women onboard)	1
Burn Preparations	•Flamazine (Silver Sulphadiazine 1% cream 50g tube)	1

Eye Drops / Ointments

Category	Items	Qty
Antibiotic	•Chloramphenicol (1% 4g ointment tube)	1
	•Neomycin Sulphate (0.5% 0.5ml Single use Drops)	20
Anti-inflammatory	•Dexamethasone (Sodium Phosphate 0.1% 0.5ml Single use drops)	20
Anaesthetic	•Amethocaine hydrochloride (0.5% 0.5ml Single use drops)	20
Hypotonic	•Pilocarpine nitrate (2% 0.5ml Single use drops)	20
Diagnostic	•Fluorescein (sodium 1% 0.5ml (detection of foreign bodies / scratches)	20

Ear/ Nasal Medicines

Category	Items	Qty
Antibiotic / anti-inflammatory	Neomycin (3,400 units, polymixin B sulphate 10,000 units), WITH Hydrocortisone (50mg / ml (5ml dropper bottle)	1
Decongestant	Ephedrine (nasal drops BP 0.5% ephedrine hydrochloride (10ml bottle)	1

Oral / Throat Infections

Category	Items	Qty
Antiseptic	•Chlorhexidine (gluconate 0.2% mouthwash 300 ml)	1

Local Anesthetics

Category	Items	Qty
Local	•Lignocaine / Lidocaine (Subcutaneous injection 1% 50mg in 5ml).	5
Dental	•Bonjela	1
Antiseptic	•Oil of Cloves (10ml)	1

Hygiene

Category	Items	Qty
Gloves	•Disposable (Latex free 25 pair per box)	1
Gloves	•Sterile Disposable (Latex free 1 pair per sterile single use pack)	5
Face Masks	•Disposable (Single use surgical masks)	6
Sheeting	•Waterproof Plastic Sheeting (1m x 2m)	1
Body Bag	•Large Body Bag	1
Nail Brush	•	1

Resuscitation Supplies

Category	Items	Qty
Oral Airway	•Oro-pharangeal Airway (Guedal Airway Sizes 3 & 4)	1 each
Aspirator	•Aspirator (to clear airways (manual, hand operated) + 2 catheters)	1
Manual Ventilation	•Pocket face mask (with valve and O_2 inlet)	1
Oxygen	•Oxygen reservoir (e.g. D Size 300ltr cylinder) •Flow meter unit (minimum setting of not less than 4ltrs per min) •24% oxygen disposable face masks •High concentration oxygen face masks & reservoir.	1 1 5 5

Medical Supplies

Category	Items	Qty
Charts	•Temperature, Pulse & Respiration	1 pad
Blood Pressure	•Aneroid Sphygmomanometer (With stethoscope)	1
Temperature	•Clinical Thermometer (Including low temperature rectal thermometer).	1 each
Tongue Depressor	•Disposable tongue depressor.	10
Magnifying Glass	•Magnifying Glass (7.5cm with handle)	1
Slides	•Microscope slides (Individual transit containers) **N.B. IN MALERIA AREAS ONLY.**	5

First Aid Supplies

Category	Items	Qty
Bandage	•Adhesive Elastic bandage (7.5cm x 4m)	1
Bandage	•Crepe bandage (7.5cm x 4m)	4
Sterile Bandage	•Med Nº 1 (12cm x 10 cm dressing with bandage)	3
Sterile Bandage	•Large Nº 2 (20cm x 15 cm dressing with bandage)	3
Sterile Bandage	•Ex Large Nº 3 (28cm x 20 cm dressing with bandage)	2
Finger Dressing	•Tubular Gauze Bandage (20m with finger applicator)	1
Adhesive Dressings	•Assorted Sterile	40
Steri-strips	•Adhesive sutures (75mm strips x5 per pack)	1
Sterile Gauze	•Packet of 5 Sterile Gauze Pads (7.5cm x 7.5cm)	5
Burn Sheet	•Sterile sheet for burn victims	1
Triangular Bandage	•Triangular Bandage for sling application	1
Paraffin Gauze	•Paraffin Gauze Dressing, Sterile (10cm x 10cm)	4

Hypodermic

Category	Items	Qty
Syringes	•Disposable Syringes (2ml, 5ml &10ml)	5 each
Needles	•Sterile Needles (Single use hypodermic 21g Green& 25g Orange)	15

Medical Supplies

Category	Items	Qty
Box	•Stainless Steel Instruments Box	1
Scissors	•Stainless Steel (Dressing, sharp pointed).	1
Forceps	•Dissecting toothed forceps	1
Clamps	•Haemostatic Clamps	1
Safety Pins	•Safety Pins, rustless medium.	6

Immobilisation

Category	Items	Qty
Finger Splint	•Malleable finger splint	1
Splint	•Malleable forearm / hand splint	1
Vacuum Splint	•Set of 4 (half leg, full leg, half arm, full arm. Preferably non inflatable)	1
Thigh Splint	•Thomas / Donway traction splint	1
Collar	•Semi Rigid adjustable neck immobilisation collar.	1
Stretcher	•Trauma Stretcher (Immobilisation equipment suited to vessel)	1

Sundries

Category	Items	Qty
Jug	•Plastic measuring jug (½ litre size)	1
Sharps Box	•1 litre, non tamper sharps disposal box	1

CONTACTING MEDICAL SUPPORT 18

A key question a first aider needs to ask is 'How urgent is the casualties injuries'?. Triage is essential.

It is vital that the first aider knows how to summon help on their specific vessel. It is essential that triage is used to categorise the medical needs of the casualty.

The potential medical interventions may include:

- First aid.
- Shore support.
- Evacuation.

Large vessels may use code words over tannoy systems for specific information:

- "Operation Bright Star" signals a medical emergency.
- "Operation Rising Star" means a passenger has passed away.
- "Code Red" - Outbreak of norovirus or. It means the ship must undergo deep cleaning and sick passengers should stay in their rooms.
- "Code Green" and "Code Yellow" indicate less severe problems.

Emergency Radio Frequencies 18.1

Maritime Emergency Frequencies

Ships with radiotelegraph station, while at sea, keep a 24 hours listening watch of 500 kHz and on 2182 kHz. Coastal radio stations keep a 24 hours listening watch on 500 kHz, 2182 kHz and some also on 8364 kHz. Ships with radiotelephone station, while at sea, keep a 24 hours listening watch on 2182 kHz. Coastal radio stations and ships with VHF radio keep listening on VHF frequency 156.8 MHz. (channel 16).

- 2182 kHz - telephony - alarm / speech
- 500 kHz - telegraphy - no longer monitored or protected as distress frequency
- 8364 kHz - telegraphy - alarm / Morse
- 156.8 MHz - telephony - speech.

Aeronautical Emergency Frequencies

Commercial air traffic keep a listening watch of 121.5 MHz. Military air traffic keep a listening watch on 243 MHz. "SEA KING" helicopters can "home" on all emergency frequencies, except of 156.8 MHz (channel 16).

Rescue helicopters may keep communication on all maritime -and aeronautical emergency frequencies. Commercial helicopters can "home" on 500 kHz and 2182 kHz.

- 121.5 MHz - Civil aeronautical emergency frequency.
- 243 MHz - Military aeronautical emergency frequency.
- 121.5 Mhz/123.1 MHz - Communication frequency.

Distress Calling

Telegraphy 500 kHz - 8364 kHz.

- Alarm signal (Distress) - "May-Day".
- Alarm signal (Urgent Assistance) - "Pan-Pan".
- Alarm signal (Safety) - "Sécurité".

Telephony 2182 kHz.

- Alarm - Two-tone alarm signal.
- Distress message - "Alarm Signal" + message.

VHF Telephony 156.8 MHz (channel 16)

- Alarm - None.
- Distress message - "Alarm Signal" + message.

Distress Message Procedure

- Alarm Signal 3 times. (i.e.: May-Day, May-Day, May-Day, Pan-Pan-Pan, Sécurité-Sécurité-Sécurité)
- This is (Your name / call sign) 3 times.
- Your position.
- Type of distress or emergency situation.
- Type of assistance requested.
- Weather condition (wind-wave-visibility etc.)
- Other information: - number of person(s) involved.
- Injured person(s) - medical assistance required.
- Emergency radio beacon/communication.

Ship and rig to shore communication should be on 2182 kHz.

It is important that all marine units involved in the emergency should maintain radio communication with the same Coastal Radio Station that is controlling the emergency traffic.

- Air to ship communication is to be on 2182 kHz RIT. However, the rescue helicopters are equipped with, and will communicate with vessels on channel 16, **VHF** emergency radio, operating on 121.5 MHz or 123.1 MHz may be used as back-up if a total loss of communication is experienced.
- Aircraft and helicopters in an emergency or rescue operation will keep a listening watch on 121.5 MHz.

Emergency Position Indicating Radio Beacons

Air traffic keeps a listening watch on the International Aeronautical Distress Frequencies 121.5 MHz VHF. Emergency position indicating beacons may therefore be used to indicate that an emergency or distress situation exists.

Rescue helicopters and aircraft can "home" on emergency beacons, thus saving search time.

Digital Selective Calling

Digital Selective Calling (DSC) is a standard for sending pre-defined digital messages via the Medium-Frequency (MF), High-Frequency (HF) and Very-High-Frequency (VHF) maritime radio systems. It is a core part of the Global Maritime Distress Safety System (GMDSS).

The DSC device will include the ship's MMSI number and coordinates, if available and, if necessary, the channel for the following radiotelephony or radiotelex messages.

Designated distress calls allow one of ten pre-defined designations to be sent along with the distress signal. These are "abandoning ship", "fire or explosion", "flooding", "collision", "grounding", "listing", "sinking", "disabled and adrift", "piracy or attack" and "man overboard". To avoid false distress alerts, distress buttons normally have protective covers.

A coast station which receives a DSC distress alert will immediately send an acknowledgment. The sending device will then both stop repeating the alert, and tune to the designated channel for the distress message to be sent. Ships receiving a distress alert who are outside coast station range or do not receive an acknowledgment, are required to relay the distress alert by any means to land.

E.T.H.A.N.E. 18.2

The following “packet” of information is a systematic way to relay the essential details to the emergency services control. This is important so that the appropriate response to the incident can begin as soon as possible.

ETHANE Can Be Used As A Neumonic For The Packet Of Information:

- **E**xact location
- **T**ype of incident / injuries
- **H**azards
- **A**ccess
- **N**umber of casualties
- **E**mergency services on scene or required

An Example Is:

’We are at the Fulmar platform 217 miles due east of Dundee. There has been a fire in the galley. One male-aged 36 is not breathing with a suspected smoke inhalation. The fire has been extinguished. Access is by platform helipad, a medic wearing hi-viz vest will be waiting at the pad; a first aider is providing life support. We need urgent evacuation with a paramedic equipped Air Ambulance.”

Secondly, you will be asked what the chief complaint is with the patient. Try to keep details to a minimum; a brief description of the problem is all that is required. If it has nothing to do with what's wrong with the patient now, then it isn't important. Things to remember are whether the patient has any serious medical history ie, diabetes, epilepsy etc. The M.I.S.T. information packet is best.

CASUALTY EVACUATION 19

Rapid pre-transfer stabilisation can dramatically increase casualty survival rate.

Casualties with serious or multiple injuries starts to deteriorate rapidly. In trauma medicine the term the 'golden hour' is very common.

The golden hour is the time immediately after injury, and it is well recognized that the immediate effective resuscitation with a rapid but systematic packaging of a casualty for transport are key goals in overall mortality rate. For every 30-minute period after the Golden Hour, the patient's chances of survival are *cut in half*.

A 'Scoop & Run' approach should be avoided if at all possible. Once the decision to evacuate a casualty has been made, the medic caring for them should commence the process of preparing the casualty for their evacuation.

Pre-Transport Stabilisation 19.1

A systematic approach should be made in the transfer of a casualty. This can be applied using the A.B.C.D.E.:

Airway Support (With Spinal Care):

Spinal immobilisation

It is likely that transportation of a casualty with cervical injuries may increase the severity of the injury.

Any Suspected Spinal Injury Should Be Transferred With:

- Definitive immobilisation, which includes:
  - Cervical Spinal Collar.
  - Head blocks.
  - Vacuum mattress / Spinal board / Scoop stretcher.

Spinal Immobilisation

Airway Support

A conservative approach should be made with regards to airway management. If the casualty has a prolonged evacuation time to a medical facility, it should be assumed that their airway needs might deteriorate. It is therefore common for a casualty who is seriously injured to be electively intubated with a R.S.I. prior to transport to maintain stability. The attempted intubation of a casualty in-flight is often unsuccessful.

The Approach To Transport Airway Support Should Include:

- Basic airway adjuncts as necessary.
- Suction:
  - Hand powered. With catheters.
- Appropriate airway transport equipment:
  - OPA, NPA.

Secure Airway

Breathing Support:

An assessment of the casualties respiratory support needs is vital prior to transport. The presumption should be made that respiratory support will need to be increased during transport. Therefore provisions should be made to accommodate this.

The Main Elements For Pre-Transport Stabilisation Are:

- Positioning:
  - Inclined upright position (if possible).
- Oxygen therapy: (A high percentage to compensate for a drop in partial pressure).
  - Appropriate mask for transport.
  - Adequate O_2 supply for intended journey, return & additional ⅓.
  - Multi-function oxygen regulators (with high and low pressure).
- Appropriate breathing transport equipment:
  - B.M.V. ventilator.
  - O_2 masks.

Position For Optimal Breathing

Administer Oxygen

Circulation Support:

An assessment of the casualty's cardiovascular needs is vital prior to transport. As always, the

presumption should be made that the casualty will become haemo-dynamically unstable during transport. Therefore provisions should be made to accommodate this.

The Main Elements For Pre-Transport Stabilisation Are:

Doubly Secure I.V.

- I.V. Access (Maintained by ships Medic):
  - Large bore (Min 18g) cannulae x 2.
  - Cannulas / drips should be **Doubly** Secured with tape.
- I.V. Fluids (Maintained by ships Medic):
  - Crystalloid, colloid. Enough for transfer & return.
- Drugs (Maintained by ships Medic):
  - Resuscitation & maintenance drugs (vasoactive / sedation / gastric)
  - Enough for transfer & return.
- Bio-medical Electronic equipment:
- Drug Infusion Device (Maintained by ships Medic):
  - Aeromedical-hyperbaric capable & fully charged.
  - Defibrillator:
    - Aeromedical-hyperbaric capable & fully charged.
- Monitors (Maintained by ships Medic):
  - Pulse, Resps, ECG, SpO_2, B/P, temperature.
  - Aeromedical-hyperbaric capable & fully charged.

Transport Equipment

Disability Support (Neurological)

Assessment of the casualty's neurological state is vital prior to transport. If a casualty has been intubated then the continual administration of sedative drugs is common. It is important to be aware that these drugs can have a profound haemo-dynamic effect (normally dropping of blood pressure). Therefore provisions should be made to accommodate this.

The aim is when using sedative drugs to administer enough to keep the patient sedated but not enough to fully anaesthetise.

RASS	RASS Description
+4	Combative, violent, danger to staff.
+3	Pulls at tube(s) or catheters; aggressive
+2	Nonpurposeful movement, fights ventilator
+1	Anxious, apprehensive , but not aggressive
0	Alert and calm
-1	Awakens to voice (eye opening) >10 sec
-2	Light sedation, briefly awakens to voice (eye opening) <10 sec
-3	Moderate sedation, movement or eye opening.
-4	Deep sedation, no response to voice, movement or eye opening to stimulation.
-5	Unarousable, no response.

The Main Elements For Pre-Transport Stabilisation Are:

- Monitoring
  - G.C.S.
- Sedation therapy (Maintained by ships Medic):
  - As prescribed. (sliding scale in accordance to the casualties neurological / sedation level).
  - Maintain sedation to -2 / -3 level.
- Analgesia (Maintained by ships Medic):
  - Give analgesia as prescribed using a pain score system.
  - Pre-load with analgesia **before** transfer.

Exposure / Environment

It is vital that the DMT evaluates the mode, duration & environmental elements of the casualty's transfer. The aim is obviously for a problem free evacuation and this is only achieved by systematic prior preparation.

The Main Elements For Pre-Transport Stabilisation Are:

- Packaging: It is vital that the casualty is well secured prior to transport.
  - Spider Harness / Straps.
  - Mummy wrapping blanket.
- Limb immobilisation:
  - Splint all fractures.
  - Ensure adequate padding.
  - Ensure visible view-ports.
- Thermal control:
  - Blankets / clothing.

Casualty Packaging

Pre-Transport Holding 19.2

You may find yourself in the unfortunate position of not being able to immediately evacuate your casualty. If this is the case you will have to provide for their basic day-to-day bodily needs.

In Conjunction With These You Will Have To Provide Some Degree Of After Care For Your Casualty:

- Regular observations.
- Updating of medical documentation.
- All treatments are refined and any tubes, cannulae or dressings are secure.
- Maintenance of or changing of dressing.
- Casualty is hydrated / fed.
- Casualty is moved to avoid pressure sore development.

Casualty Transport Checker		
Issue	**Generic**	**Specific**
Spinal Care / Immobilisation	Spinal immobilisation	Collars, blocks, tape. Vacuum mattress / spinal board
	Limb immobilisation	Splints, with adequate padding & view ports
Airway	Airway support	Ensure airway device **Doubly** Secured with tape.
	Spare Airway support	Masks, OPA, NPA.
	Suction	Hand powered. With catheters.
Breathing	Oxygen	Adequate supply for intended journey, return & additional ⅓.
		Oxygen Regulators with high and low pressure connectors for all types of delivery.
Cardiovascular	I.V. Access	Large bore cannulae x 2 **doubly** Secured with tape. **(Medic Responsible).**
	Fluids	Crystalloid, colloid. Enough for journey ++. **(Medic Responsible).**
	Drugs	Resuscitation & maintenance. Enough for journey ++. **(Medic Responsible).**
	Defibrillator	A.E.D.
	Monitors	ECG, SpO_2, B/P, temperature as a minimum. **(Medic Responsible).**
Disability (C.N.S.)	Analgesia	Use analgesia scale, send enough for journey +/-. **(Medic Responsible).**
Environmental	Thermal control	Blankets / clothing.
	Securing Device	Spider Harness, Straps, Mummy Wrapping blanket.
Sundries	Documentation	Dive Injury Report, Neuro Form, GCS Obs, First Aid Form, Fluid Balance, Accident Form, Accident form.
	Necessities	Clothing suitable for location & money.
	Immediate survival	Passport, water, food, money.
	Communications	radio, phone, locator beacon,

Evacuation By Helicopter 19.3

Evacuation by helicopter is common with a seriously injured casualty. There are two options:

- Deck winching.
- Helicopter landing on vessel / land with lateral casualty transfer.

Helicopter Winch Rescue 19.3.1

- Brief your crew **before** the helicopter arrives if possible.
- A member of crew should monitor VHF radio at all times.
- In most cases the winchman will approach on the port quarter.
- Beware of F.O.D. (Foreign Object Damage).
  - Secure all loose gear on deck, or stow it below.
  - Unsecured covers, ropes, unstowed clothing, are easily lifted by the down-draught of the rotors.
  - They can be sucked into the helicopter's air intakes and threaten engine failure.
- When the rescue helicopter arrives:
  - In most cases the winchman will approach on the port quarter.
  - He may drop a line down to the deck with a sand-filled weight on it. Let it land on deck to earth.
  - You may be required to pull the winchman toward you.
  - He may give you hand signals.
  - **DO NOT** tie the line to the vessel or yourself!
  - Follow all the winchman's instruction.
  - Assist in securing the casualty.

Approaching A Landed Helicopter 19.3.2

- Do not approach within 30 metres of a helicopter, or leave the aircraft without a clear signal from the aircrew to do so. A *thumbs up* by day, a *one flash of light* (by torch) by night.

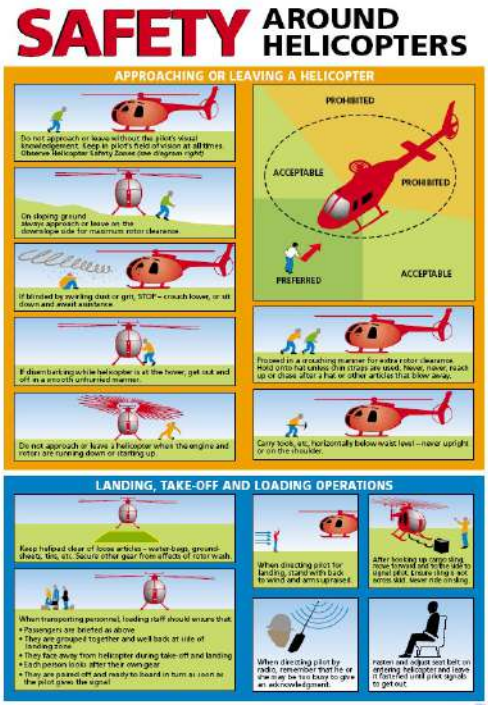
- Always approach the aircraft from the correct direction.
  - In general, this is the 2–3 o'clock position.
  - Except for the Chinook / Merlin, which is approached from the 4/5 o'clock or 7/8 o'clock position.
- Particular care is to be taken when working on sloping or uneven ground.
  - Remember, on an uphill slope the rotor blades will be nearer the ground.

Casualties May Have To Be Loaded While The Rotor Blades Are Still Turning:

- Because of the downwash created by the rotor blades, all headgear is to be removed and loose articles secured, before approaching the aircraft.

General Safety

- No smoking inside or within 15 metres of the aircraft.
- Personal belongings must be kept to a minimum.
- Do not enter the inside of the cabin unless instructed to do so.
- Do not touch anything while inside the cabin unless instructed to do so.
- All helicopters are extremely noisy aircraft. This noise is to be considered a hazard and hearing protection is to be worn when in their vicinity (including casualties).



Super Puma 19.3.3

The Puma is a single main rotor, twin engine helicopter. Its main role is to provide tactical support but is often used in a casevac role.

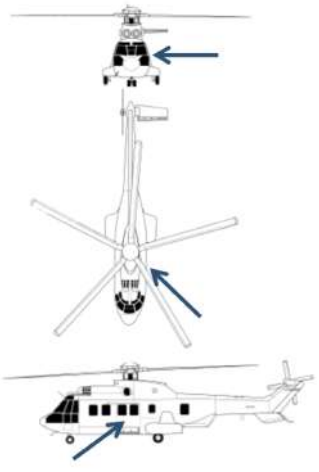
This extremely versatile aircraft, when conditions dictate, can accommodate usually two stretchers (but can take three) or six walking casualties (or a combination between the two maximums) in the rapid reaction role.

Super Puma

Danger Points

- Main rotor. The main rotor is 15.8m in diameter and drops to a low point of 3.65m on level ground.
- Tail rotor. The tail rotor is 3.05m in diameter and reaches a low point of 2.05m on level ground.
- Fragile windows and doors. The main cabin doors, the cockpit access door and the co-pilot's jettisonable panel are all made of light-alloy and transparent materials. Use care when operating the cabin door and stay well clear of these areas when in flight.

Approaching Super Puma (10 o'clock)



Loading Sequence

- The ready position is 30m out from the helicopter at the 10 o'clock position.
- Emplaning. Approach the helicopter **when** signalled to do so by the aircrew.
- The approach is from the ready position to the starboard cabin door.
- Casualties are loaded feet first and are secured with their heads forward (except when contraindicated by the casualty's injuries, particularly those with head injuries who, whenever possible, should **not** fly in a head-down position).
- The stretchers are loaded in the following sequence.
  - Port rear.
  - Starboard rear.
  - Port centre.
- Unloading is the reverse of loading.

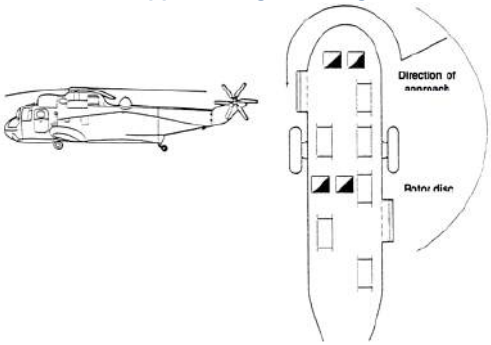
The Sea King 19.3.4

The Sea King is a single main rotored, twin engined, all weather tactical support helicopter.

This aircraft is extremely versatile but is primarily used for troop transport, carriage of under slung loads and search and rescue. In the rapid reaction role, up to six stretchers can be secured to the floor.

This layout is heavily dependent on the aircraft's configuration and the theatre of operation. In a combat zone, it will be more likely to carry four stretchers.

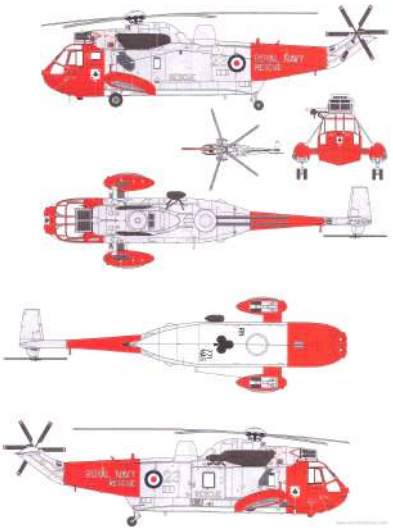
Approaching Sea King



Danger Points

- Main rotor. The main rotor is 21.34m in diameter and drops low as the blades slow to a halt. **Do not enter the disc area during engine shut down.**
- Engine intakes and exhausts. The engine intakes are situated above the cockpit and the exhaust gases are blown to the side and may radiate up to 8m from the main rotor assembly.
- Tail rotor. The tail rotor is 3.96m in diameter and reaches a low point of 2.74m on level ground.
- Other danger areas include the Floatation Bag Canister covers (can travel up to 60m when operated). There is also an Ice Accretion Indicator at eye level on the forward port side.

Sea King



Loading Sequence

- The ready position is 30m out from the aircraft at the 2 o'clock position.
- Emplaning. The approach is from the ready position to the main starboard side door. The casualties are loaded headfirst into the cabin and positioned with their head forward, the exception again being those with head injuries.

M.I.S.T. CASUALTY HANDOVER 19.3.5

The patient handover is a fundamental part of the medical transport procedure. Clinical information and the observations of the pre-hospital providers on the mechanism of injury are valuable in the ongoing evaluation of the casualty.

A MIST handover provides a short, rapid and structured format to present the critical information at hand over to a medical facility in a concise and structured format.

M.I.S.T. stands for: Mechanism, Injuries, Signs & Treatment.

- **M**echanism
  Brief details of events, e.g. motor vehicle crash, fell from 15ft roof. This information provides the hospital with a context and helps appraisal for predictable injuries.
- **I**njuries
  A concise description is given of the injuries discovered, e.g. broken leg, and their location.
- **S**igns
  The initial vital signs are relayed in an A.B.C.D.E. format. Any changes in the vital signs that have occurred en route should be stated.
- **T**reatment & **T**imes
  Some of these will be visibly obvious such as the use of a splint and when it occurred. These are essential pieces of information that dictate clinical priorities for the hospital Team.

Essential Information

DOCUMENTATION 20

There is a simple rule about injuries that happen in a marine setting. If it is not documented it did not happen.

Accurate documentation is vitally important as a legal record of any marine based accidents.

Ships Accident Book 20.1

Any accident at sea, no matter how small, must be recorded in an accident boot accident book may be filled in by any person on behalf of the casualty (or indeed by the casualty themselves).

The information recorded can help the vessel manager identify accident trends and identify possible needs for improvement in the control of health and safety risks. It can be used for future first aid risk assessments and may be helpful for insurance investigative purposes.

The First Aider often completes the accident book, so the following notes are given for your advice:

- An accident book is a legal document.
- Anything that has been written down at the time of an incident is usually considered to be 'stronger evidence' in court than something recalled from memory.
- Complete the report all at the same time, using the same pen (not pencil).
- To comply with the Data Protection Act, personal details entered in accident books should be kept confidential.
- A member of staff should be nominated to be responsible for the safekeeping completed accident records (e.g. in a lockable cabinet). Hand the completed accident record to that person.
- The person who had the accident may wish to take a photocopy of the report. If this is the case, they can do this before it is handed in. They should keep a record of accident report number.
- The name, address and occupation of the person who had the accident.
- The name, address, occupation and signature of the person who is completing the report.
- The date, time and location of the accident.
- A description of how the accident happened, giving the cause if you can.
- Details of the injury suffered.
- Subjective opinion should be avoided.

Accident Book

First Aid Report Form 20.2

It is useful for a first aider to complete a First Aid Report Form for every patient treated. Please note that this does not replace the accident book, which would still have to be completed for an accident at work.

A patient report form is designed so the first aider can keep a record of the exact treatment provided. It is particularly useful if a patient refuses treatment against the advice of the first aider.

- If a patient refuses treatment, make sure they are capable of making that decision (e.g. a fully conscious adult). Seek medical advice if they are not.
- Follow the advice given for completing the accident book when completing the form.
- A copy of the form can be given to coast guard, ambulance or hospital staff, as it will contain valuable information about the incident and treatment of the patient. Ask the nurse to take a copy so you can keep the original.
- To comply with the Data Protection Act, personal details on the report form must be a confidential, so the report should be stored securely (e.g. in a lockable cabinet).

If time permits an A.M.P.L.E. History can be very useful. This stands for:

- **A** **A**llergies.
- **M** **M**edication.
- **P** **P**revious Medical History.
- **L** **L**ast Meal.
- **E** **E**vents leading up to Injury

We have provided an example First Aid Report Form. Feel free to photocopy

First Aid Patient Report Form

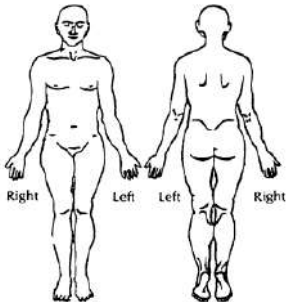
Inspection Date:		**Inspection Time:**			
First Aider					
Patient Name		**D.o.B:**		**Age:**	
Patient Contact Details					
Location of Incident:					

Patient Observation *(Record every 10 mins)*

Time	Breathing Rate	Pulse Rate	C.R.T.	Estimated B.P.	A.V.P.U. Score
	B.P.M.	B.P.M.	Secs	MMHg	
	B.P.M.	B.P.M.	Secs	MMHg	
	B.P.M.	B.P.M.	Secs	MMHg	
	B.P.M.	B.P.M.	Secs	MMHg	
	B.P.M.	B.P.M.	Secs	MMHg	
	B.P.M.	B.P.M.	Secs	MMHg	
	B.P.M.	B.P.M.	Secs	MMHg	
	B.P.M.	B.P.M.	Secs	MMHg	

A.V.P.U. Score			Breathing Rate	Pulse Rate	C.R.T.	Estimated B.P.
ALERT	Fully Alert	6	< 8 Emergency	< 40 Emergency	< 2 Secs	
	Confused	5 Caution	< 12 Caution	40 – 60 High Caution		> 90 Mg Hb Palpable Radial Pulse
VOICE	Inapropriate Words	4 Caution	12 - 16	60 - 90	2 – 3 Secs Caution	
	Utters Sounds	3 Caution	16 – 20 Caution	90 – 120 Caution	3 -4 Secs Caution	> 70 Mg Hb Palpable Femoral Pulse Danger
	Localises Pain	2 Danger	20 – 30 Caution	120 – 140 High Caution		
PAIN	Inappropriate Response	1 Emergency	30 – 40 High Caution	140 – 170 Danger	4 – 5 Secs Danger	
UNRESPONSIVE	No Response	1 Emergency	> 40 Emergency	> 170 Emergency	> 5 Secs Emergency	> 60 Mg Hb Palpable Carotid Pulse Emergency

A.M.P.L.E. Survey

Allergies	
Medication	
Past Medical History	
Last Eaten	
***M*echanism of Injury (Events)**	
***I*njuries Sustained & *S*ymptoms**	Airway: Breathing: Circulation: Disability: Exposure: 
***T*reatment & *T*imes**	
What Happened Afterwards ?	**Casualty Went:-** Evacuated ☐ Shore Consult ☐ Returned To Duties ☐ Refusal of Treatment ☐

Signature of Patient		**Date**
Signature of First Aider		**Date**

Example of a First Aid Report Form. Please Photocopy & Use

R.I.D.D.O.R. 20.3

If any injuries are sustained within U.K. waters (or if your vessel is U.K. registered) then certain injuries are reportable to the H.S.E. under its RIDDOR system.

RIDDOR stands for the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, 1995.

The following need to be reported:

- Deaths
- Major injuries
- Accidents resulting in over 3 days of injury time off work.
- Diseases
- Dangerous occurrences
- Gas incidents

All incidents can be reported to the H.S.E. in a variety of way (online, telephone, e-mail & post). Go to: www.hse.gov.uk/riddor/index.htm for more information.

Reporting accidents is clearly regulated and obliges compliance.

R.I.D.D.O.R. Reporting

GLOSSARY OF TERMS 21

Abdomen
The portion of the body between the thorax and the pelvis containing the majority of the organs of digestion as well as the liver and spleen.

Acidosis
The condition of an excess concentration of hydrogen ions in the body. (This is the opposite of alkalosis.) This may be as a result of either a metabolic problem or a respiratory problem. Treatment relies on correcting the cause of the imbalance.

Acute hypoxia
Sudden fall in oxygen concentration within the blood stream. It may be caused by air way obstruction, lung failure or cardiac failure. Signs may be subtle such as confusion or more obvious such as acute loss of consciousness

Airway
The passage allowing free movement of air into and out of the lungs. The term is also used to describe clinical devices for maintenance of a patent airway; these may range from simple devices such as Guedel airways to endotracheal tubes.

Alkalosis
The condition of a decrease in the body's concentration of hydrogen ions or an increase in bicarbonate ions. Like acidosis, this may be caused by respiratory (hyperventilation) or metabolic causes (the ingestion of excess bicarbonate or loss of excess gastric acid following vomiting).

Allergy
Abnormal sensitivity to normally harmless antigens. In the severest form this may result in an anaphylactic reaction.

Amputation
The loss of a digit, limb or appendage, either deliberately (surgically) or as a result of trauma.

Anaemia
An abnormally low haemoglobin concentration in the blood.

Analgesic
A pain-relieving drug.

Anaphylactic reaction
An extreme reaction to an allergen characterised by release of histamine from cells of the immune system and resulting in generalized itching, angi -oedema, collapse, tachycardia, bronchospasm and (in the worst cases) death.

Anterior
In front of or at the forward limits of the body.

Antibiotic
A drug with antibacterial actions.

Antigen
A substance, usually a protein, the body regards as foreign and against which it produces an antibody in an attempt to render the antigen harmless.

Apnoea
Absence of breathing.

Artery
Blood vessel supplying tissues with oxygenated blood.

Auscultation
Listening and interpreting sounds as heard through the stethoscope.

Axilla
The armpit.

Blood pressure (BP)
The pressure exerted by the circulating blood on the arteries as it is pumped around the circulation.

Bradycardia
An unusually slow pulse rate, generally understood to be less than 60 beats/ min, though this may be normal in a fit, young individual.

Bronchus
The division of the trachea leading down to the alveoli; the two first divisions after the trachea are known as the right and left main bronchi.

Burn
An injury caused by extremes of temperature – hot or cold. Classified as full-thickness or partial-thickness, depending how deep is the extent of tissue damage. Other causes of burns include chemicals and electricity

Carbon dioxide retention
An increase in the concentration of carbon dioxide within the blood stream, often secondary to respiratory failure.

Carbon monoxide (CO)
A colourless, odourless gas. It has the ability to combine with haemoglobin in an almost irreversible manner, displacing oxygen and causing hypoxia of the tissues.

Cardiac output
The volume of blood pumped out by the heart in one minute. It is derived from the stroke volume (the amount of blood pumped per heartbeat) multiplied by heart rate.

Carotid arteries
The two major arteries that can be felt in the neck giving arterial supply to the face and brain.

Cerebral oedema
An increase in the fluid around the cells in brain tissue with resultant swelling. A number of causes include head injury (the most common). It may present with signs of raised intracranial pressure owing to the closed nature of the skull.

Chin-lift
A manoeuvre to open the airway by pulling forward the point of the chin.

Clavicle
(The Collar bone) The supporting bone articulating between the scapula and the sternum.

Coagulopathy
An abnormal condition characterised by a decreased ability of the blood to clot. In trauma, this may be caused by continual bleeding and an inadequate replacement of coagulation factors after large blood loss.

Coma
Deep unconsciousness with no response to vocal or painful stimuli and absence of spontaneous eye movement.

Concussion
A limited period of unconsciousness caused by injury to the head.

Conjunctiva
The membrane that lines the eyelids and the sclera of the eye.

Contrecoup
The head injury sustained on the opposite side of the head to the site of the blow. It results from the movement of the soft brain against the cranium on the opposite side.

Contusion
The result of a blow to the body which fails to break the skin but produces swelling, bruising and pain.

Cornea
The transparent covering over the anterior part of the eye.

Cranium
The bony framework of the skull.

Cerebrospinal fluid (CSF)
The fluid surrounding the brain and spinal cord.

Cutaneous
Pertaining to the skin.

Cyanosis
The blue colour seen at the periphery or centrally caused by the inadequate oxygenation of blood, which thus contains too much deoxyhaemoglobin which has a bluish colour.

Dead space
The area of the lung that is in contact with oxygen but is not being perfused with blood; also applied to the volume of air that is contained within the trachea and the bronchi which never reaches the gas exchange surface.

Diaphragm
The musculotendinous sheet that separates the thoracic cavity from the abdominal cavity.

Diastole
The period of time during the cardiac cycle when the heart is relaxed and blood enters the atria or ventricles.

Diastolic blood pressure
The systemic blood pressure during diastole. It rises slightly in the early phases of hypovolaemic shock.

Dislocation
The displacement of any joint from its normal anatomical site and relationship with the surrounding tissues and bones.

Distal
Further away along the body or a limb from a reference point.

Dyspnoea
Shortness of breath whether as a result of disease or as a result of excessive exercise.

Electrocardio-Gram (ECG)
A trace of the electrical activity of the heart normally taken as 12 differing views of the heart. Used to diagnose abnormalities of the heart such as arrhythmias and myocardial infarction.

Epidermis
Protective structure that overhangs the larynx and hinges backwards during swallowing to prevent food entering the larynx.

Extradural
Literally, outside the dura; particularly refers to the cerebral bleed associated with a temporal fracture where the middle meningeal artery bleeds into the extradural space compressing the cerebral substance.

Femur
The thigh bone.

Fibula
The small outer (lateral) bone of the lower leg.

Flail chest
A chest wall that as a result of trauma has two rows of multiple rib fractures leading to paradoxical movement.

Flexion
Movement between two bones, generally in a direction to decrease the angle between them.

Fracture
An injury to the bone at which the continuity of the bone is broken. There are a variety of

classifications, but one important feature of note is whether the skin has been broken over the fracture site (compound or open fracture) or not (closed).

Gag reflex
The reflex occurring in response to irritation of the pharynx.

Gangrene
Death of tissue, often due to inadequate blood supply as the main cause, though a variety of other conditions such as cold injury may also cause gangrenous changes. Often divided into wet or dry gangrene: typically, wet gangrene follows major tissue damage such as crush injury.

Glasgow Coma Scale (GCS)
A swift method for assessing and monitoring the conscious level of a patient. It is based on the eye response, the verbal response and motor response.

Guarding
The contraction of the abdominal muscles to protect a painful area from the pressure of an examining hand.

Haematoma
A collection of blood within the tissues; this may be as a direct result of trauma or of surgery.

Haematuria
Passage of blood in the urine.

Haemoglobin (HB)
The red pigment found in red blood cells that is responsible for the carriage of oxygen around the body.

Haemorrhage
The loss of blood – a term normally referring to rapid loss of a large quantity of blood either internally or externally.

Haemothorax
The filling of a pleural cavity with blood, usually after trauma to the chest or following thoracic surgery.

Hepatic/hepato
Pertaining to the liver.

Hyper-
Prefix meaning increased.

Hypercapnia (hypercarbia)
A high level of carbon dioxide in the blood.

Hypertension
Disorder of blood pressure control that results in an elevated blood pressure.

Hypervolaemia
A larger than required circulating volume, generally the result of overtransfusion, though overdrinking (particularly in the presence of reduced renal function) may also give rise to it.

Hypo -
Prefix meaning low or inadequate.

Hypotension
A low blood pressure which is inadequate for perfusion of the vital organs. This may be as a result of abnormalities of the heart, side effects of drugs in excess or loss of circulating fluid (for example bleeding).

Hypothermia
A pathologically low body temperature (normally defined as below 35°C), most frequently due to exposure to cold conditions.

Hypovolaemia
A state of low blood volume. *See also* Hypovolaemic **shock.**

Hypovolaemic shock
The state of inadequate perfusion (and therefore oxygenation of the tissues) due to a fall in the circulating volume (usually due to blood loss) and a subsequent fall in blood pressure. Excessive loss of body fluids due to other causes (for example, diarrhoea) can also occasionally cause this.

Hypoxaemia
Low level of oxygen in the blood.

Hypoxia
A fall in the concentration of oxygen in cells. This may result from inadequate oxygenation due to a decrease in atmospheric oxygen, inadequate respiration (due to a reduction in the respiratory drive, an obstruction of the respiratory tract or lung injury) or inadequate circulation (for example, shock).

Infra -
Prefix meaning below or beneath.

Inter-
Prefix meaning between.

Intra -
Prefix meaning within.

Intravenous (IV)
Into a vein (administration of fluid or drugs.

Ischaemia
An inadequate flow of blood to part of the body, caused by constriction or blockage of the blood vessels supplying it.

Jaw-thrust
A manoeuvre to open the airway by pushing the mandible forward, normally with the fingers behind the angle of the mandible.

Joint
A junction between two bones. This may be classified in a number of ways, for example by its structure (for example, a ball and socket joint such as the hip) or by its type (for example, fibrous, cartilaginous or synovial).

Jugular
Pertaining to the neck (for example, jugular vein, the major vein running on the right and left of the neck alongside the carotid artery draining blood from the face and head).

Lactic acid
One of the waste products of protein and carbohydrate metabolism. It may accumulate in certain conditions to cause a metabolic acidosis.

Laparotomy
Surgical exploration of the abdominal cavity.

Laryngo-
Relating to the larynx.

Lateral
A position on the body further from the midline relative to another point.

Log roll
Manoeuvre to move a casualty to expose the back but maintaining in-line stability of the whole spine.

Lumbar
(Latin *lumbus*, the loin) General term referring to the lower back between the thorax and the pelvis, (for example, lumbar spine).

Malleolus
(Latin, a little hammer) Rounded, bony protuberances found on the inner (medial) and outer (lateral) aspect of the ankles.

Medial
Towards the midline.

Mediastinum
(Latin, a middle partition) The middle cavity of the thorax within which the heart, the trachea (and its bifurcation), the great vessels and the oesophagus are contained.

Narcotic
A drug that has pain-relieving properties and causes sleep.

Necrosis
The death of tissue, often due to ischaemia.

Neurogenic shock
The condition of low blood pressure due to an injury to the spinal cord resulting in widespread dilatation of blood vessels.

Oedema
An abnormal collection of fluid around tissue and cells or within tissue spaces.

Oesophagus
The muscular structure that carries food from the oropharynx to the stomach, linking the two structures.

Open Pneumothorax
The collapse of a lung with entry of air into the pleural space and direct communication of the pleural space with the external environment. Also known as a 'sucking' chest wound.

Ophthalmo-
Relating to the eye.

Opiates/opiods
Morphine and related drugs which may be used for pain relief. They have a tendency to cause respiratory depression and nausea. They maybe administered subcutaneously, intramuscularly or intravenously.

Osteo-
Relating to bone or bony.

Oxygen
A colourless and odourless gas which is vital for cellular metabolism. In conditions of shock and respiratory deficiency its supplementation forms an important part of therapy.

Palpation
To examine a casualty by feeling with the hand(s).

Pancreas
A large glandular retroperitoneal structure lying across the posterior midline of the abdomen.

Paradoxical breathing
Generally associated with traumatic damage to the chest, resulting in instability of the chest wall such that on inspiration the chest wall collapses in and the lung fails to expand.

Perfusion
The passage of blood through a tissue at a rate adequate to supply it with necessary nutrients and remove toxic metabolites.

Peri-
Prefix meaning around.

Peritoneum
The lining membrane of the abdominal cavity, enfolding all the abdominal cavity. Organs in the abdomen may be within the peritoneal cavity or retroperitoneal (behind the peritoneal cavity): examples of the latter are the kidneys and pancreas.

Peritonitis
Inflammation of the abdominal cavity due to bacterial, chemical or other causes. The most common causes include appendicitis, perforation of an ulcer or perforation of the small or large bowel.

PH
The measure of acid and base balance within the body. It is a measure of the concentration of hydrogen ions present in the blood (the log of the reciprocal of the hydrogen ion concentration). Normal body pH is 7.4. In cases of acidosis (metabolic or respiratory) the pH falls. In alkalotic conditions (metabolic or respiratory alkalosis) the pH rises.

Pharynx
The throat. It is divided into the nasal cavity (nasopharynx). the oral cavity (oropharynx) and the larynx (laryngopharynx).

Pleura
The lining tissue that coats the inside of the thoracic cavity, the mediastinal contents and the lungs, allowing movement of the lungs relative to the thoracic wall.

Pneumothorax
A collection of air within the pleural space leading to collapse of the lung. This may be caused by a spontaneous leak from the lung or from perforation of the thoracic wall, (for example, in stabbing). When a leak exists with a 'one-way valve' effect, the pressure of the pneumothorax may increase, leading to distortion of the mediastinum, decreased venous return and collapse: this is known as a tension pneumothorax.

Postero-
Prefix meaning back.

Pre -
Prefix meaning in front of.

Pro-
Prefix meaning before.

Proximal
Usually referring to a point on a limb which is closer to the trunk than another point, (for example, the elbow is more proximal than the fingers).

Pulmonary
Pertaining to the lungs and respiratory system.

Pulmonary oedema
The accumulation of excess fluid, firstly within the interstitial tissues of the lung and in severe cases within the actual alveoli of the lungs. Most commonly caused by congestive cardiac failure, though also associated with other acute conditions such as following acute head injury, near drowning and following inhalation injuries.

Pulse
The expansion and contraction of an artery as a result of the intermittent flow of arterial blood; can be detected by palpation or other means.

Pulse Pressure
The difference between the systolic and diastolic blood pressure. A reduction in the pulse pressure as a result of an increase in the diastolic pressure may be one of the first and subtle signs of shock.

Radial pulse
The pulse of the radial artery which can be felt in the wrist; because of the ease with which it can be felt, it is the most frequently palpated.

Rebound tenderness
The pain felt on sudden release of a hand palpating the abdomen. It is seen in conditions of inflammation of the peritoneum.

Referred pain
Pain felt at one site but caused by disease at another anatomical site, (for example, hip disease may present with knee pain).

Respiration
The process of inhaling oxygen-rich atmospheric air and exhaling carbon dioxide-enriched air.
At a cellular level, the process of cellular exchange of oxygen as a fuel, metabolising it into carbon dioxide and excreting it.

Respiratory acidosis
The condition of increased carbon dioxide and carbonic acid (thus an increased hydrogen ion concentration) due to failure of excretion of carbon dioxide by the lungs. This may be due to suppression of the respiratory centre in the brain (for example, head injury, drugs, and so on) or lung disease.

Respiratory alkalosis
A condition characterised by a decrease in the concentration of carbon dioxide in the blood stream. Like respiratory acidosis it may be caused by lung disease, through hyperventilation and excess excretion of carbon dioxide (for example, asthma or pneumonia). Other causes may include drugs and a variety of medical conditions.

Retro-
Prefix meaning behind.

Rule of nines
An approximate formula that may be used to calculate the surface area of a burn: 9% is allocated to each arm and the head; 18% (2 x 9) to each leg and the front and back of the trunk; and 1% to the perineum.

Sacrum
The penultimate segment of the lower bony spine. It lies between the two hipbones, articulating with them via the sacroiliac joints.

Scapula
The bone forming the shoulder blade.

Semi-
Prefix meaning half.

Septic Shock
A form of shock secondary to the release of toxins from certain bacteria when they infect a patient. These cause decrease in the vascular resistance and a drop in blood pressure. Fever, an increased respiratory rate and confusion may also be features.

Shock
Reduced perfusion of tissues inadequate to maintain their metabolic rate and oxygenation. It may have many causes, which fall into five main groups: hypovolaemic, septic, cardiogenic, spinal and anaphylactic.

Skin Traction
A method for attaching bandage or material (either adhesive or non-adhesive) to the skin of a limb in order to apply a corrective force reducing a fracture or orthopaedic deformity.

Sphygmomano-meter
A device for measuring the arterial blood pressure.

Spinal Cord Injury
Traumatic damage of the spinal cord. The results depend on the level of the cord where the injury occurs and the severity of the cord damage. Cord damage below C5 and above T1 is associated with quadriplegia, while damage below T1 produces paraplegia. The effects depend on the severity of the damage and may range from temporary to permanent. Transection of the cord is associated with spinal shock characterised by warm peripheries, low blood pressure and absence of sensation and movement below the level of the injury.

Spine
The collective term for the group of bones which articulate together to form the backbone. It contains the spinal cord.

Spleen
A vascular organ in the upper left quadrant of the abdomen. Its role is primarily producing cells for the lymphoreticular system. Traumatic damage may result in severe haemorrhage owing to its vascular nature.

Splint
Any device that may be used to immobilise an injured part of the body.

Sternum
The breastbone

Sub-
Prefix meaning under.

Subarachnoid Haemorrhage
The presence of blood within the subarachnoid space.

Supra -
Prefix meaning above.

Surgical Emphysema
The presence of gas in the subcutaneous or deep tissues of the body that has been forced there due to a leak of air from the lungs or trachea (rarely the gut). It may indicate the presence of a penetrating neck wound or a pneumothorax, for example.

Systole
The part of the cardiac cycle in which the heart contracts and blood is expelled into the aorta.

Tachycardia
An abnormally fast pulse rate, generally defined as a pulse rate above 100 beats per minute.

Thoraco-
Relating to the chest.

Thready Pulse
A pulse that is weak or difficult to feel: may be related to a small pulse volume (pulse pressure) secondary to shock.

Tibia
The main weightbearing bone of the lower limb below the knee joint.

Trachea
The main air passage connecting the lungs to the oropharynx and nasopharynx.

Traction
The placement of a limb or body part under tension; often used in orthopaedics to correct deformity, realign broken bones and as a temporary method of pain relief at a fracture site.

Trans-
Prefix meaning across or over.

Transverse
At right angles to the long axis of the body (this plane is also at right angles to the coronal and sagittal planes).

Triage
The classification and sorting of casualties into groups based on the severity of injury and chance of survival. Successful triage aims to do the most for the most, even if resources are limited.

Ulna
The long bone of the forearm that runs on the inner aspect from the elbow to the wrist. At the elbow it forms the olecranon.

Unconsciousness
The inability to sense and respond to external stimuli, due to a variety of causes.

Valsalva Manoeuvre
Breathing out against a closed glottis to increase intrathoracic pressure.

Vasoconstriction
The narrowing of the blood vessels, particularly the arterioles and veins. This may be accomplished by a variety of stimuli and is useful in the response to shock or to control blood pressure.

Vasodilatation
The widening of the various small vessels (see vasoconstriction) brought about by relaxation of the smooth muscle in the walls of the vessels.

Ventilation
The process of exchanging gases from within the lung to the atmosphere.

Vertebra
One of the constituent bones of the spinal column. It may be a cervical, thoracic, lumbar, sacral or coccygeal vertebra.

Whiplash injury
Forced flexion/extension injury of the neck often seen following a road traffic accident.

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