WHAT HAPPENS IF . . . ?

Lesson Objectives

Diver training is "preventive" training, not only in teaching diving skills but anticipating how to recognise and resolve problems should they arise. As students are at an early level of training, some of the areas considered are for their awareness rather than in-depth knowledge and will be built on through later diver training grades

Achievement Targets

At the end of this lesson students should

- Understand that anticipating problems is part of training and planning
- Understand the cause, effects and resolution of potential problems relating to:
    - DCI, effects of nitrogen and lung damage
    - Nitrogen narcosis
    - Oxygen toxicity
    - Air
- Understand that oxygen administration is a first aid tool for divers and recompression treatment should be sought following any abnormalities present after a dive
- Understand the importance of resolving underwater problems early
- How to effect a rescue

Following items will be useful as additional Visual Aids

Oxygen administration kit

WHAT HAPPENS IF . . . . ?

AIMS

This session considers what happens if a particular problem arises when diving. Students may already be aware of resolving at least one of the problems in this lesson from practical training i.e. the out of gas'/AS situation. However, there are also some new areas, which, although not directly applicable to this level of diving such as narcosis, students are likely to hear about when they begin diving with other more experienced divers:

Potential problem areas to be covered are

- Decompression Illness (DCI)
  - Involving gas bubbles
  - Involving lung damage
- Nitrogen narcosis
- Oxygen toxicity
- Breathing gas
  - Contamination
  - Loss

Also this lesson covers resolving problems by

- Effecting a rescue - different types of rescue

DCI - NITROGEN

Reviewing what was learned in OT4, 'Planning to go diving', the students should be reminded about nitrogen release

Nitrogen Release

- An ascent will not release all the nitrogen absorbed on a dive
- Any ascent has to be controlled with good buoyancy
- Nitrogen continues to be released for many hours following a dive
- Another dive within this time period adds to nitrogen levels retained in the body
- Planning and managing nitrogen on dives to minimise the risk of DCI, divers use:
  - Tables or computers to plan dives
  - Good dive practice
  - Suitable Nitrox mixes

DCI - GAS BUBBLES

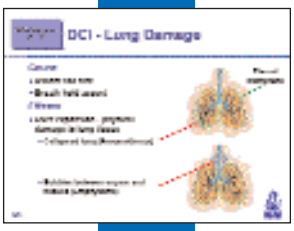
Causes

- Nitrogen bubbles can be caused by inadequate elimination of nitrogen during an ascent
- Gas Bubbles, called gas emboli, caused by lung damage during ascent

Effects

- Bubbles can form in tissues (remember the fizzy drink) and they can
  - Distort and disrupt the tissues
  - Compress or damage the blood vessel supplying the tissue
  - This will reduce oxygen delivery to cells downstream of the blockage causing oxygen starvation of the tissues
- Bubbles can also form in/enter the blood
  - They can combine to form larger bubbles that block blood flow

- Blood vessel blockage will starve downstream tissues of oxygen and disrupt the body's functions



DCI - LUNG DAMAGE

Damage to the lungs can result no only in gas bubbles passing into the bloodstream, but also in gas pockets between the tissues/organs in the chest.

Cause

- Ascent is too fast
- A breath hold ascent

Effects

- Over expansion of breathing gas in the lungs causes physical damage to lung tissue and tiny blood vessels
  - Gas escaping from damaged alveoli can pass through the thin membrane sac surrounding the lungs, into the chest cavity. Expansion of this gas on ascent can cause the lung to "collapse" - Pneumothorax
  - Gas escaping from damaged alveoli can also travel between the tissues around the lungs and heart in the chest cavity up to the neck - Emphysema

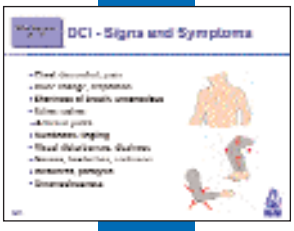
DCI - SIGNS AND SYMPTOMS

Symptoms can appear from within seconds to many hours after surfacing from a dive.

One of the first indications of DCI is

- Denial

Divers will often deny anything is wrong. Getting DCI is not something to be embarrassed about, but it does need resolving as quickly as possible when signs and symptoms appear. And the longer the denial period, the worse a diver could become and the more complex the treatment needed.



DCI - SIGNS AND SYMPTOMS

Do not worry about differentiating the causes of DCI, the treatment will be the same. Some or all of the following may be present (not in any order):

- Chest discomfort or pain
- Voice change, crepitation (crackling of skin caused by bubbles under the skin's surface - like 'bubble-wrap')
- Shortness of breath
- Itches and rashes
- Aches around joints
- Numbness or tingling - 'pins and needles' sensation
- Visual disturbances, dizziness
- Nausea, headaches, confusion
- Weakness or paralysis
- Unconsciousness

DCI - TREATMENT

There is only one way to resolve DCI:

- Urgent treatment is required in a Recompression Chamber
- The treatment recompresses the diver in a chamber to reduce the bubbles in the body to promote the restoration of circulation to affected areas. However, the longer DCI is left unattended, the more likely that damage to tissues may not be resolved which can have serious consequences

- Recompression facilities have Diving Medics who provide specialist supervision of any treatment

Divers' first aid tool - oxygen

Because DCI is a serious condition, divers use a first aid tool on dive sites, oxygen. *(Point out/show to students your branch or centre's Oxygen administration kit or, if diving is carried out from hard boats, emphasise that the Dive Manager ensures there is oxygen on board. Training is given by the BSAC in oxygen administration and is open to divers of a minimum qualification of Ocean Diver).*

- The benefit of Oxygen administration is that it increases the oxygen levels in the blood and helps to improve oxygen delivery to damaged tissues
- It also assists in eliminating nitrogen from the body, by eliminating nitrogen from the inspired gas

NITROGEN NARCOSIS

Students may hear other divers refer to Nitrogen Narcosis or "the Narks" and, although unlikely to affect them at their level of diving, the following explains what Narcosis is.

Cause

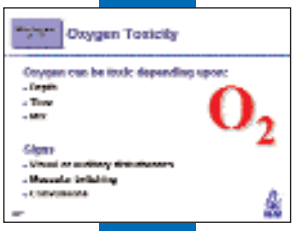
- It is thought that Nitrogen under pressure affects the transmission of impulses in the nerve cells. Generally this is only noticed when divers go beyond 30m but actually starts much shallower

Signs

- Generally similar to the effects of alcohol, said by some to be the 'raptures of the deep', most divers experience narcosis as anxiety or worry. Some divers deny they ever get it

Resolution

- Re-ascending to shallow depths immediately resolves narcosis



OXYGEN TOXICITY

Students may recall earlier references to Oxygen Toxicity (OT4). Although very unlikely to affect them at their level of diving, the following explains what Oxygen Toxicity is. While there are actually two types of Oxygen Toxicity, this section concerns only Acute Oxygen Toxicity.

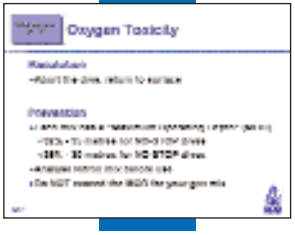
Cause

Oxygen can be toxic when breathed at high partial pressures (Partial pressures will be explained in Sports Diver Training). Oxygen toxicity determines the Maximum Operating Depth (MOD) for a particular mix, but staying within that MOD does not guarantee freedom from oxygen toxicity. The length of time that oxygen is breathed at high partial pressures is also a major consideration.

Signs and symptoms

The following symptoms do not necessarily happen in this order and some may not happen at all.

- Visual or auditory disturbances, including dizziness or nausea
- Muscular twitching of the face, lips, or fingers
- Fatigue, or general tiredness
- More seriously, convulsions



Resolution

- Abort the dive, return to surface

Prevention

Each Nitrox Mix has a "Maximum Operating Depth" (MOD) which, for no-stop dives is 35 metres for Nitrox 32, and 30 metres for Nitrox 36.

- Analyse your Nitrox mix before use
- Do NOT exceed the MOD for your Nitrox mix.

Remind students that Ocean Divers are restricted to 20m depth.

CONTAMINATED BREATHING GAS SUPPLY

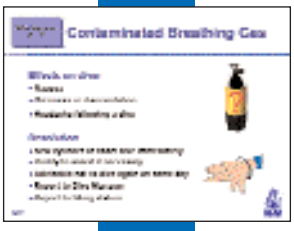
Students may hear reference to a "bad fill".

Cause

This is when there has been a contamination problem in the compressor when filling cylinders. Whether at a branch or dive centre, compressors work to stringent breathing gas purity standards and, fortunately, bad breathing gas fills are few and far between. However, problems do sometimes arise

Detection

- An oily taste or smell may be detected prior to the dive when checking equipment. Depending on the contamination level this may not become apparent until actually on the dive
- If there is contamination, there is a possibility that it may be carbon monoxide but this cannot be detected on its own by taste or smell. Carbon monoxide reduces the efficiency of the blood delivery of oxygen to the cells. Students will probably be aware of people who have suffered from carbon monoxide poisoning from faulty heaters or boilers in the home. Although this poisoning is generally over a longer period of time than a diver will be exposed to, it is the increased pressure that magnifies the effect when diving. This is why there are stringent breathing gas purity standards for breathing gas filling stations
- If bad breathing gas is detected before a dive, do not dive with the contaminated cylinder



CONTAMINATED BREATHING GAS

Effects on the diver

Apart from the taste, if present

- The diver may also begin to feel nauseous
- They may become dizzy or disoriented
- There may be no apparent sign of contamination before or during the dive, but a headache after a dive

Resolution

- If bad breathing gas is detected during a dive, the dive should be aborted. The ‘something wrong’ sign should be given. The buddy should remain very close throughout the ascent to assist if necessary
  1. Upon surfacing, breathing normal air should resolve giddiness or nausea but a headache may persist
  2. It is advisable not to dive again on that day, and a wise diver allows a sufficient recovery period
  3. Seek medical advice/assistance
- The bad breathing gas fill and any effects a diver has had or is still experiencing must be reported to the Dive Manager. The diver will be monitored for a period following the dive as is normal when any abnormality occurs during or after a dive
- The bad breathing gas fill must be reported to the filling station. They may be unaware of the problem and need to rectify it as soon as possible

THE INCIDENT PIT

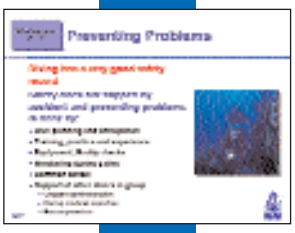
Resolving problems, particularly early on if underwater, does prevent more serious consequences that could occur. In many instances, divers train for "worst case

scenarios" so they can assist on less serious cases with a high degree of proficiency.

Incidents rarely happen as the result of just one factor but, more commonly, are the result of a combination of factors. Each factor in isolation may be quite innocuous but, as the combination builds, the stress on the diver increases ever more rapidly until it is beyond their capabilities.

This effect has been likened to a pit whose sides become steeper and steeper the further one descends - do not fall in.

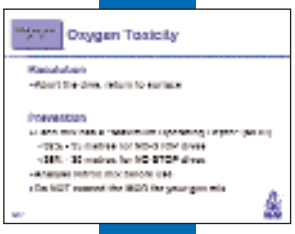
- While the slope is gentle it is easy to retain one's footing and to climb back out - minor incidents can be resolved
- As the descent continues, one's footing becomes less sure and it becomes more and more difficult to climb out. Minor incidents escalate into emergencies which become more difficult to resolve
- Ultimately, all grip is lost and the resulting slide into oblivion at the bottom of the pit is irreversible - serious then fatal. Severity of the emergency exceeds the ability for resolution with fatal consequences
- Resolving an underwater problem early prevents more serious consequences



PREVENTING PROBLEMS

Diving has a very good safety record but safety does not happen by accident and problems are prevented by

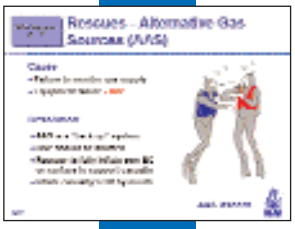
- Dive Planning and anticipating conditions
- Training, practise and experience
- Ensuring equipment is serviced, working and buddy checked
- Monitoring self and buddy during a dive
- Taking a common sense approach about fitness to dive and not diving beyond capabilities
- Having the support of other divers in the dive group with skills in
  - Rescue management
  - Administer oxygen first aid
  - Seek diving medical expertise



PREVENTION AND RESOLUTION

- With any problem, prevention is better than cure
- Acting early regains control of the problem
- Buddy diving and monitoring is of great importance
- To resolve a problem either the diver does so, or the buddy assists or the buddy effects a rescue

Prevention and resolution both rely on rescue skills being continually practised.



RESCUES - ALTERNATIVE SUPPLIES (AS)

Cause

- Failure to monitor breathing gas supply
- Equipment failure - rare

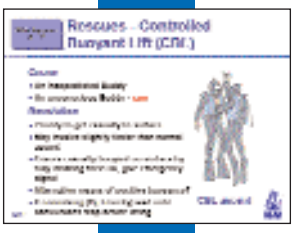
Resolution

- Using an an alternative supply (octopus, pony cylinder etc.). The AS should always be regarded as a "back up" system for such diving emergencies. It is a piece of equipment that needs to be checked on the buddy check. It is also advisable to check it again underwater early in the dive
- If an 'out of gas' situation occurs, this must be treated as an emergency

and a controlled AS ascent should be made

NB. The ascent considerations depend on type of dive being undertaken. If diving at the base of a wall or slope or shot line, then an ascent using these reference points is preferable, but if out of sight of a reference point, a direct ascent should be made

- The rescuer should fully inflate their own BC on the surface
- The casualty's BC should be inflated, with total air loss this will need to be by the BC mouthpiece or emergency cylinder (if fitted), and signal for help
- Ditching weightbelt should be considered
- Where the casualty is suffering from convulsions due to oxygen toxicity, it is likely that their breathing stops and their airway becomes obstructed. At this point, any ascent to the surface could result in a burst lung. Under such circumstances, wait until the convulsions have stopped before lifting the casualty



RESCUES - CONTROLLED BUOYANT LIFT (CBL)

Cause

- A diver may become incapacitated by injury or stress and need assistance to the surface
- A diver may become unconscious through illness

Resolution

- The priority is to get the casualty to the surface, particularly when they are unconscious
- For training of the CBL, it is done in a very controlled manner but in reality a CBL may mean a slightly faster than normal ascent. This may incur a decompression penalty but that can be resolved on the surface - not getting to the surface means no resolution
- Following the CBL and on reaching the surface, the rescuer must firstly ensure the casualty is buoyant by fully inflating both BCs to prevent them sinking before surface assistance reaches the divers and give the emergency signal
- Where the casualty's breathing gas supply is exhausted, an alternate means of achieving positive buoyancy, such as dumping the casualty's weights/weightbelt, or using the BC emergency inflation cylinder (if fitted), will need to be used. This may result in a less controlled rate of ascent, but this is far preferable to an unsuccessful lift

RESCUES - FREE ASCENT

Purpose

- This is where a diver is effecting a self-rescue as a last resort. There is no second chance and the ascent must result in the diver reaching the surface.

Resolution

Depending on the diver's buoyancy

- Finning upwards for a short distance will commence the ascent and then the expansion of gas in the diver's suit or BC, or the suit material, will provide sufficient buoyancy to continue the ascent.
- If the diver is over weighted at depth, then finning will require too much effort. The diver will need to jettison their weight system. This needs to be done carefully and the weightbelt/weights held clear of the diver before release to ensure they do not snag on any other equipment and prevent the diver's ascent

- Once the weight system has been released there is little the diver can do to control the rate of ascent. Creating a "drag" effect by spreading arms and legs and angling fins will help. The diver should exhale as deeply as possible to counteract the rapidly decreasing ambient pressure

RESCUES - SURFACE SUPPORT

For Ocean Divers, the resolution of a rescue requires that they get the casualty/their buddy to the surface.

- From that point on, the more experienced divers in the group, or surface cover, can organise and handle the surface recovery and any additional assistance that may be required. A rescuing diver signaling distress, or a lone diver appearing on the surface, will activate the surface support to provide assistance
- Following any abnormal ascent, even if it is a controlled rescue ascent such as using an AS, the divers involved will automatically be monitored by the Dive Manager and other divers following the dive
- If any abnormalities occur following an ascent, then oxygen first aid will be administered
- Where necessary, the Dive Manager will contact a diving medical specialist for further advice and/or arrange evacuation by the emergency services
- With DCI cases, urgent recompression treatment is needed and this will be immediately co-coordinated by the Dive Manager

SUMMARY

Diver Training is not just learning and practising diving skills but understanding that planning and anticipating problems may prevent minor incidents becoming more serious.

This lesson has looked at:

- Decompression Illness (DCI)
- Nitrogen narcosis
- How to effect rescues and the support that other divers in the group will give