

LESSON 40

SCUBA DIVING EMERGENCIES

Text Reference: Outdoor Emergency Care 4th edition, Chapter 15 Page 433 (3rd page 483)

LESSON OBJECTIVES

Upon completion of this lesson and any required assignments, the student will be able to:

1. Describe and discuss the following problems as they may occur in sport diving:
 - descent problems
 - bottom time related problems
 - ascent related problems
 - decompression illness (arterial gas embolism, decompression sickness)
2. Discuss concerns associated with air transportation of patients following SCUBA related accidents.
3. Access agencies which may provide information and/or assistance in diving related accidents.



Left: Diver descending beside the wreck of the Habbakuk, a top secret WWII aircraft carrier project scuttled in Patricia Lake in Jasper National Park

Top: Underwater plaque located at the dive site.
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Responding to SCUBA Diving Emergencies

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OVERVIEW OF LESSON CONTENTS

Scuba diving is very popular on Canada's east and west coasts. In addition, anyone intimately familiar with Canada's national park system is aware of Fathom Five National Marine Park in Ontario. This park contains 21 shipwrecks and over 25 popular dive sites. Many people are not aware of the diversity of locations in which recreational scuba diving takes place in other parts of the country. For example, recreational scuba diving takes place in Canada's north off

the coast of Baffin Island and in lakes, great and small, across the country including in the mountains.

Of particular interest to the PER student is the extensive scuba diving activity that takes place in the mountain parks of western Canada. Every weekend in the summer dozens of divers cluster around the popular lakes in Waterton Lakes, Jasper and Banff National Parks. The cities of Lethbridge, Calgary, Red Deer and Edmonton feed scores of divers to these cold deep lakes which technically class as “altitude diving”.

During class your instructor will present the information at the basic level required for you to meet the lesson objectives. Since the national parks no longer have dive rescue teams, it is important for PER students to understand the basic treatment of dive related accidents. The latter part of this lesson contains more detailed information for PERs who are trained as divers, divemasters (or higher) or those working in an area in which extensive scuba diving takes place.

Diving Problems and the Diving Environment

The acronym SCUBA refers to the fact that underwater diving is facilitated through the use of “self contained underwater breathing apparatus”. In the two decades since the PER program was created the nature of scuba diving equipment and technique has dramatically changed. The assessment and treatment of diving related illness and injury has also evolved.



The first part of this lesson will focus solely on the use of compressed air as a breathing gas in standard recreational dives to a maximum of 40m / 130 feet. Once on the surface, emergency care for those breathing compressed air versus those breathing other exotic mixtures of gases is identical. Once a diver reaches a recompression chamber the nature of the gas the diver was breathing becomes more relevant.

The majority of the dive related problems discussed in this lesson can be classed as “barotrauma” or trauma related to pressure. At sea level the ambient atmospheric pressure is about 14.7 psi or 1 atmosphere absolute. With increases in depth comes a rise in pressure. For every additional 10 meters that the diver descends the ambient pressure increases by 1 atmosphere. At 40m, the limit of recreational diving, the ambient pressure has now increased to 5 atmospheres. (The difference between salt and fresh water is neglected for simplicity.)

As the diver descends and the ambient pressure increases the result would eventually be a collapsed chest. In order to allow the diver to breathe normally, the two stage scuba regulator delivers air to the diver at the same pressure as the ambient water pressure. Breathing air under high pressure is the cause of the serious dive illnesses discussed under the heading of decompression illness.

Occurrences of Problems

There are over 5,000,000 divers in the US but only 100 deaths per year.

Non – Fatal (more common)

30% - Cuts & Scratches

30% - Hypothermia

30% - Ear & Sinus Squeezes

10% - Decompression Illness, Marine Animal Injuries, Near – Drowning

Fatal (rare)

75% - Drowning (Panic, Blackout, Cardiac Arrest, Equipment Problems)

20% - Arterial Gas Embolism

5% - Decompression Sickness, Marine Animal Injuries, CO Poisoning, Trauma

Onset of Problems

Problems may occur during any phase of a scuba dive

- Descent: squeezes, ruptured eardrum
- Bottom: narcosis, equipment failure, contaminated gas, hypothermia
- Ascent: arterial gas embolism (AGE)
- Post - Dive: decompression sickness (DCS)

Descent Injuries

Squeezes are caused when a diver descends and pressure on a body cavity is not been equalized. Normally, the diver will discontinue descent if pain is encountered. If ear pain is encountered during descent, divers should discontinue the descent. If the diver continues to descend, rupture of the eardrum (tympanic membrane) can occur. Treatment consists of supportive treatment and transportation. Take a full history to be sure

Bottom Problems

Nitrogen Narcosis is caused by breathing air, which is 79% Nitrogen, under increased pressure. The high partial pressure of nitrogen acts on the nervous system to create an altered level of consciousness often similar to intoxication. It normally occurs only on deep dives (>30m) but susceptibility is highly variable. As the diver ascends the symptoms disappear and no treatment is required unless the diver's behaviour leads to another injury.

Hypoxia during a dive may result from equipment failure (rare), or running out of air while below the surface. Once the diver has been brought to the surface treatment should include airway management, CPR as required, supplemental oxygen and rapid transportation. Suction should be available.

Carbon Monoxide (CO) Poisoning can occur any time a scuba tank is filled with contaminated air. Because the diver is breathing the contaminated air under high pressure the symptoms can occur very rapidly. Symptoms include headache, nausea, vertigo and dizziness during the dive. The diver may show mental dullness and neurological deficits after surfacing. This may be confused with decompression illness. Cherry red skin coloration can occur but is rare. The treatment for CO poisoning is the same as for Decompression Illness (see below).

Ascent & Post Dive Problems - Decompression Illness

“Decompression illness (DCI) is the term used to describe the signs and symptoms of an injury caused by breathing compressed gas at depth. It encompasses both arterial gas embolism (AGE) and decompression sickness (DCS) injuries. First aid treatment for both AGE and DCS is the same.” Source DAN 2005

Signs and symptoms can be severe or they may be vague and largely ignored by the diver until they become worse. They may begin to occur during the ascent or in some cases may be delayed up to 24 hours. The diver may no longer be wearing their dive gear or wetsuit.

Common Signs & Symptoms Source DAN 2005

- Altered skin sensation, numbness and tingling
- Pain
- Dizziness and vertigo
- Difficulty walking

Other possible less common, signs and symptoms include:

- Rash & Itching
- Difficulty breathing
- Changes in vision
- Paralysis
- Unconsciousness
- Personality change
- Altered speech
- Inability to urinate
- Hearing loss or ringing in the ears
- Convulsions

Arterial Gas Embolism (AGE) “results when air is trapped in the alveoli and expands during ascent. It may result if a diver ascends from a depth while holding his/her breath. Gas may be forced through the thin alveolar lining directly into the bloodstream, with little or no physical damage to lung tissue, or; gas expansion may cause the alveoli to rupture introducing gas either into the bloodstream or into the surrounding tissues. Gas introduced into the bloodstream returns to the heart and may go directly to the brain causing symptoms that are rapid and dramatic.” Source DAN 2005

Decompression sickness (DCS) can result from a rapid ascent to the surface or from staying down too deep or for too long. During the dive, the air the diver breathes is at greater than normal pressure, and larger than normal amounts of nitrogen are dissolved in and accumulate in the blood and body tissues. The quantity is related to the depth and duration of the dive. DCS is sometimes also called the “bends” and divers sometimes refer to getting the bends as “getting a hit of the bends” or simply “getting a hit”.

Volume of Nitrogen Dissolved in the Body at Saturation

FEET	METERS	LITRES
0	0	1
33	10	2
66	20	3
100	30	4
130	40	5

Normally a diver uses a set of tables or a dive computer to determine the maximum safe length of stay at any given depth, based on the amount of nitrogen that will be dissolved in the blood. If the diver ascends slowly, excess dissolved nitrogen is eliminated through the lungs rapidly enough to prevent decompression sickness. Cautious divers make a safety stop at 5m / 15 feet for three minutes to further eliminate nitrogen. DCS can occur without exceeding safe limits in some rare instances.

“DCS occurs due to bubble formation and growth during and after ascent. It can include distortion or tearing of tissue, reduction or stoppage of blood flow, and activation of blood clotting mechanisms. The formation of these nitrogen bubbles may cause direct tissue damage or the bubbles may block the flow of oxygenated blood to tissues including the spinal cord. Symptoms of DCS in divers often are described as vague and may be ignored until the symptoms get worse or persist.” Source DAN 2005

After the dive approximately 2/3 of the total nitrogen is eliminated in one hour and 90% in six hours post dive. Some excess nitrogen will be present in various tissues in the body for many

hours. After multiple dives for multiple days there may be some residual nitrogen present for up to 24 hours and divers should not fly for 18 or more hours after repetitive diving.

Treatment for Decompression Illness or CO Poisoning Related to Diving

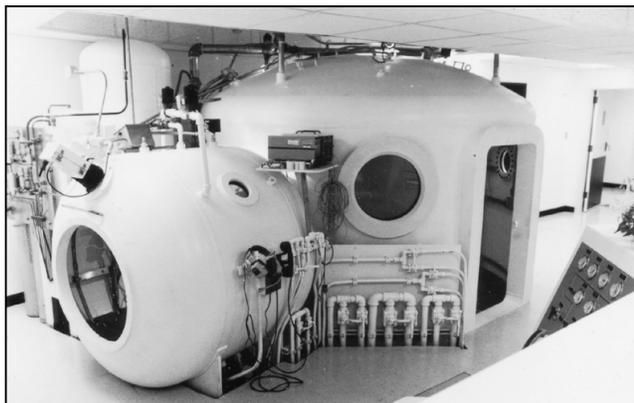
- Provide Basic Life Support according to normal protocols
- Administer **oxygen at 15 LPM by non-rebreather mask or via FROPV**
- Place patient in **supine position if conscious (Durant position is no longer used)**
- Place patient in **recovery position if diminished level of consciousness**
- Take and record a very detailed history (see advanced notes below)
- Contact EMS to arrange for transportation to a recompression chamber
- If air transportation is used, **FLY LOW**. Attempt to gain no more than 500 feet / 150m above the altitude of the dive site. A pressurized aircraft is best.

Emergency Numbers for Diving Accidents - DAN 1-919-684-8111

Ensure EMS / ambulance has been dispatched first. Then have your dispatcher contact the Divers Alert Network (DAN) at the Duke University Medical Centre. DAN has a physician trained in dive medicine on call 24 hours a day. They can advise you and the EMS attendants in regard to the best course of treatment. They can also help make all of the arrangements for proper transportation of a diver to the nearest recompression chamber if required.

Recompression Chambers

The definitive treatment for decompression illness and CO poisoning is recompression and slow controlled decompression in a hyperbaric chamber while breathing special blends of gases. It is **DANGEROUS** to attempt to recompress a diver by returning him/her to the water with another scuba tank. If they have been at the surface for any appreciable interval, this will be contraindicated.



Advanced Notes On Assessment Of Diving Injuries

It is important to obtain as complete a history of the diving accident as possible. In addition to the information you would normally gather when taking a complete set of vitals, take a SAMPLE history, OPQRST and Ins & Outs. Then ask the following:

- Do you have a dive computer or dive log? (send with patient to advanced care)
- How many dives have you done and at what altitude ?
- How long and how deep was your last dive ?
- Did you make any decompression stops ?
- Was the ascent: rapid? Emergency? Slow?
- Were there any problems on descent or ascent?
- Were you breathing air or some other mixed gas (Nitrox / Trimix) ?
- Dive buddy may have other information
- Call DAN for more advice!

If you are trained in the DAN On-site Neurological Assessment, complete the Neurological exam every hour and record the findings and any changes on your slate. There are five general areas of concern that are evaluated in the on-site neurological assessment. These include:

- Mental Function
- Cranial Nerves
- Motor Function (Strength)
- Sensory Function
- Coordination and Balance

Notes:

Common Signs & Symptoms of DCI (includes arterial gas embolism, decompression sickness):

Other possible less common, signs and symptoms include:

Treatment for Decompression Illness (DCI) or Suspected CO Poisoning Related to Diving:

Note on flying patient to an emergency facility:

Phone Number for Divers Alert Network: