



GUIDELINE 9.3.5

RESUSCITATION OF DIVERS WHO HAVE USED COMPRESSED GAS

INTRODUCTION

'Compressed gas' divers breathe gas (usually air) while under water. Most commonly, divers use SCUBA (Self-contained Underwater Breathing Apparatus) and breathe from cylinders carried underwater, but the breathing gas can also be supplied from the surface (hookah supply). Whichever method is used to supply the gas, breathing compressed gas underwater can lead to several unique medical problems, the most significant being decompression illness (DCI) and pulmonary barotrauma (rupture of small airways). In addition, divers may suffer from the same aquatic mishaps as swimmers, snorkellers and boating enthusiasts.

Decompression illness and pulmonary barotrauma require special first aid considerations, including the prompt and continued administration of near-100% oxygen.

Diagnosis of the exact problem in an ill or injured diver is often unnecessary for effective first aid; it is however, important to also consider non-diving-related causes of the presenting condition.

BACKGROUND

Decompression Sickness

During an air dive, nitrogen from the inhaled gas is dissolved in the diver's blood. Unless the diver ascends slowly enough to allow the excess nitrogen to leave the body in a controlled manner, nitrogen bubbles may form in the diver's blood and body tissues. These bubbles, and the biochemical changes associated with them, can reduce the blood supply to various organs causing hypoxia and subsequent damage. This is known as Decompression Sickness (DCS). Some deep divers breathe mixtures of gas containing helium, and may face the same problems due to helium bubbles.

Pulmonary Barotrauma

As a diver ascends, the gas in the lungs expands and, unless expanding gas is adequately exhaled, the diver's lungs can distend and tear. This can result in a collapsed lung (pneumothorax) and/or trapping of gas in the mediastinum (mediastinal emphysema), or under the skin (subcutaneous emphysema). Escaped gas may also enter the cerebral arterial circulation (cerebral arterial gas embolism or CAGE) causing ranging from confusion and irritability similar to that of a stroke.

Decompression Illness

The term *decompression illness* (DCI) is commonly used to collectively describe both DCS and CAGE. Whether a diver has suffered DCS or has a CAGE may be very difficult to tell, particularly in the context of an emergency situation, the treatment strategy is the same for both conditions. It is however, critical to rapidly identify and treat any large pneumothorax (collapsed lung) that may potentially impede breathing.

RECOGNITION

Decompression Illness

- extreme fatigue
- numbness/tingling or altered sensations
- headache or other body pain, especially at or around joints
- poor balance or coordination
- irritability, confusion or reduced consciousness,
- weakness, paralysis, physical collapse
- rash
- speech, visual or hearing disturbances

Pulmonary Barotrauma

- chest pain
- difficulty breathing
- coughing
- blueness of lips and tongue (cyanosis)
- voice changes
- difficulty swallowing
- ‘crackly’ skin around neck (crepitus)
- reduced responsiveness
- signs/symptoms of decompression illness may also be present

MANAGEMENT

- If the victim is unconscious, manage as per ARC Basic Life Support flowchart (Guideline 8). A victim of DCI may regain consciousness and appear to have recovered but still needs to be managed for suspected DCI due to the possibility of relapse.
- Promptly provide as close to 100% oxygen as possible and continue to do so until the ambulance arrives and takes over management.¹ [Class A]
- If DCI is suspected, lay the victim flat if possible.^{2,3} [Class A]
- Seek immediate diving medical advice by calling the DAN Diving Emergency Service hotline on 1800-088-200 (from within Australia) and +61-8-8212 9242 (from outside Australia).
- Assist with any transfer to a recompression chamber if requested to do so.
- An alert and stable victim thought to be suffering from DCI may drink non-alcoholic fluids, such as water, isotonic/electrolyte fluids (as long as they have no stomach cramps, nausea, urinary retention or paralysis)⁴ [Class A].
- Record details of the dive(s), the first aid given and the response to first aid.

NOTES

- The Divers Alert Network (DAN) Diving Emergency Services (DES) is a 24-hour emergency hotline available to all diving related injuries. The hotline provides advice and management on diving-related illness and injury.
- Entonox (50% nitrous oxide gas in oxygen) must not be used in diving accidents [Expert consensus]

RATIONALE

A flat (horizontal) posture without leg elevation is recommended in injured divers suspected of DCI as it has been shown to increase the rate of inert gas elimination^{2,3}. It may also reduce the likelihood of arterial bubbles migrating to the brain [Expert Consensus]. However, if a conscious diver is having increased difficulty breathing when supine, they can be placed in a position of comfort.

Administration of 100% oxygen reduces the size and number of gas bubbles in the bloodstream and tissues by helping to eliminate the inert gas in the bubbles and blood^{1,5}

REFERENCES

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2. Balldin UI, Lundgren CEG, Lundvall J, et al. Changes in the elimination of ¹³³Xe from the anterior tibial muscle in man induced by immersion in water and by shifts in body position. *Aerosp Med* 1971; 42:489-93.
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4. Yogendram S, Asokumar B, Cheng DC, et al. A prospective randomized double-blinded study of the effects of intravenous fluid on adverse outcomes in outpatient surgery. *Anesth Analg* 1995;80:682-6.
5. Hyldegaard O, Moller M, Madsen J. Effect of He-O₂, O₂, and N₂O-O₂ breathing on injected bubbles in spinal white matter. *Undersea Biomed Res* 1991;18:361-71.

FURTHER READING

1. Moon RE. Treatment of Decompression Illness. In: Bove AA and Davis JC (eds). *Diving Medicine* (4th ed) Philadelphia: Saunders, 2004: 195-217.
2. Lippmann J. *Oxygen First Aid*. (Asia-Pacific Ed) Melbourne: JL Publications, 2011.
3. Lippmann J, Bugg S. *The DAN Emergency Handbook* (7th Ed). Melbourne: JL Publications, 2010.

ARC Guideline 3 Unconsciousness

ARC Guideline 8 Cardiopulmonary Resuscitation

ARC Guideline 9.3.2 Resuscitation of the Drowning Victim

ARC Guideline 10.4 The Use of Oxygen in Emergencies