Emergency Medical Retrieval Service (EMRS)

www.emrs.scot.nhs.uk

Standard Operating Procedure
EMRS Internal Use

<table>
<thead>
<tr>
<th>Title</th>
<th>Diving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version</td>
<td>5</td>
</tr>
<tr>
<td>Related Documents</td>
<td></td>
</tr>
<tr>
<td>Author</td>
<td>Dr R Price, Dr A Inglis</td>
</tr>
<tr>
<td>Reviewer</td>
<td>Dr A Corfield</td>
</tr>
</tbody>
</table>

Aims

☐ To summarise the terminology and pathology associated with diving incidents.
☐ To guide the management of diving related injury.
☐ To list appropriate local decompression facilities.

Background

- EMRS catchment includes areas popular for recreational and commercial diving

Application

- EMRS doctors
- SAS airwing Paramedics
- Medical staff in EMRS catchment area

Patients appropriate for EMRS activation / Policy

- Those requiring critical care support of A, B, C or D issues to allow safe transfer
- Realistically any EMRS involvement is likely to be transfer to Aberdeen

Advice to GP prior to team arrival

Early medical advice should be sought from the ‘Duty Hyperbaric Medicine Consultant’ at Aberdeen Royal Infirmary: 0845 408 6008
Pathology associated with diving incidents.

1. **Decompression Sickness** *(DCS, “the bends”, Caissons disease)*
   - Due to formation of nitrogen bubbles in the circulation.
   - May be delayed up to 2 weeks: all neurological symptoms are DCS until proven otherwise. Caused by an ascent profile that is too rapid.
   - May occur within the “safe” diving limits suggested by dive tables and computers as there is individual variability.
   - More likely with dehydration, cold, obesity.
   - Bubbles cause mechanical obstruction of blood vessels and an inflammatory response
   
   | B | Pulmonary: dyspnoea and haemoptysis |
   | D | CNS: visual, intellectual, paraesthesia, ataxia, paralysis |
   | E | Joint pains, rash and itching |

2. **Pulmonary Over-Pressurisation Syndrome (POPS)**
   - Expansion of trapped alveolar gas leads to alveolar rupture
   - Caused from rapid ascent with breath-holding, bronchospasm.
   - Leads to: pneumothorax, pneumomediastinum, surgical emphysema

3. **Cerebral Arterial Gas Embolism (CAGE):**
   - Consequence of POPS or DCS with a patent foramen ovale
   - Difficult to distinguish from DCS but much more rapid in onset
   - Motor and sensory symptoms from the middle cerebral artery distribution
   - Together with DCS, also considered as Decompression Injury (DCI)

4. **Non-pulmonary barotraumas**
   - Any gas filled cavity can be affected by gas expansion on ascent
   - Most commonly this can cause tympanic membrane rupture and severe sinus pain

5. **Oxygen Toxicity**
   - Breathing air beyond 50m depth leads to a toxic PaO₂. Also possible breathing Nitrox (oxygen enriched air, usually 30% O₂ to reduce incidence of DCI) deeper than about 30m.
   - PaO₂ and duration of exposure are relevant.
   - Technical (non-air gas mix) divers may use 100% oxygen in the shallow part of the ascent from depth to assist the removal of tissue nitrogen.
   - Wide variety of symptoms: mood changes, facial twitching, hallucinations, CVS collapse, convulsions and syncope.
6. Nitrogen Narcosis
- High PN₂ at a depth >40m acts essentially as an anaesthetic causing dysphoria and confusion
- Always relieved by ascent but may be the cause of accident in divers breathing air

7. Other pathology
- Diving is also associated with injuries that do not directly relate to the breathing of compressed gas, including: head injury, hypothermia and drowning

Medical Management
- The principles are oxygen and hyperbaric chamber treatment
  - Oxygen
    - response does not preclude the need for hyperbaric chamber treatment
    - most divers carry oxygen; it may have been applied as a first aid measure
    - needs to be continuous high flow by trauma mask
- Lay flat – to dissuade bubbles from migrating cephalad (and in case of hypothermia)
- Hydration – hypovolaemia occurs due to cold and immersion diuresis, capillary leak and prior dehydration
- Hypothermia, treat conventionally
- C-spine: as directed by history, unlikely to be a concern in simple diving pathology

HEMS considerations:
- Be aware of tidal activity, prepare for rotor-running offload in tidal landing zones.
- Other divers may provide a history; they may have followed a similar dive profile and also be susceptible to the same problem. They ought to know how to remove dive equipment
- Undo any quick release buckles on the Buoyancy Control Device (BCD) (looks like a webbing vest); the tank and regulator come away with this.
- The tank works with a demand regulator and is safe, lay it down flat
- A weight belt may be apparent, or integrated within the BCD
- Dive computer is often worn like a watch, but is sometimes integrated into the depth gauge. Retain if possible for analysis of the dive profile.
- Fins are removed usually with quick release buckles
- The hood is easiest cut off
- Most divers in the area use dry-suits (although some use thick wetsuits in summer months). A dry suit is likely to flood if the diver panics or is man-handled. It should be removed. This will need to be with TuffCut or clothing scissors. Expect a fleece undersuit, that will provide some insulation if wet.
### Transport issues
- Any diver risks DCI at altitude whether going for recompression or not
- Road transfers also may induce relevant altitude changes (e.g. A83 Rest and Be Thankful, 246m)
- Balance of urgency of transfer against safety aspects of a potentially prolonged minimum safe altitude helicopter flight
- Current recommendations are cabin altitude <500feet
- King Air aircraft can be pressurised to near sea level

### Triage

#### NHS Facilities [www.sdm.scot.nhs.uk](http://www.sdm.scot.nhs.uk)
- **Aberdeen Royal Infirmary** NB this is the only unit that is appropriate for ICU patients
  - Tel. 0845 408 6008 – ask for Duty Hyperbaric Consultant [www.hyperchamber.com](http://www.hyperchamber.com)
- **Millport**, Isle of Cumbrae, University Marine Biology Station tel. 01475 530581 [www.gla.ac.uk/centres/marinestation/facilities/diving_frame.html](http://www.gla.ac.uk/centres/marinestation/facilities/diving_frame.html)
- **Oban**, Dunstaffnage Marine Laboratory, Tel. 01631 559000 [www.nfsd.org.uk](http://www.nfsd.org.uk)
  - **Orkney** hyperbaric chamber, Old Academy, Back Road, Stromness
    - Contact via Balfour hospital, Kirkwall (tel. 01856 888000)

#### Non-NHS facilities
- **Faslane**, Royal Navy Tel. 01436 810947
- **Fort William**, Underwater centre
  - Tel. 01397-703786 [http://theunderwatercentre.co.uk](http://theunderwatercentre.co.uk)
- Many diving sites list a centre at Kishorn but this is now closed.

### References

[www.sehd.scot.nhs.uk/emergencyplanning/Documents/annex_i.htm#top](http://www.sehd.scot.nhs.uk/emergencyplanning/Documents/annex_i.htm#top)
Diving medicine. *Travel Medicine and Infectious Diseases* 2006; 4: 238-254
Transfers with DCI. *Prehospital Emergency Care* 2006; 10: 482-487