General

Hyperbaric Medicine Unit, Past, Present and Future

M Glover

Introduction

Following cessation of clinical activity on the site of Royal Hospital Haslar in July 2009, the Hyperbaric Medicine Unit relocated to St Richard’s Hospital in Chichester and re-opened for treatment of MOD diving casualties in January 2010. After two years in operation, the new unit has established itself favourably with local clinicians and emergency services, treating civilian and military personnel with a range of acute and chronic conditions.

Roles

The primary role of the Hyperbaric Medicine Unit is to provide treatment for any casualties that arise from military diving training at the Defence Diving School. Fortunately such casualties are infrequent but, since inexperience is associated with likelihood of a diving accident, the natural choice of location for a fixed facility is close to the diving training establishment.

Another important role of the unit is to allow the diving medical officers at the Institute of Naval Medicine and the Submarine Escape Training Tank to acquire and to maintain competence in treatment of diving accidents.

Although the hyperbaric medicine unit’s priority is treatment of diving disorders, the greater proportion of treatments administered are for a range of other urgent and elective disorders, typically selected from those approved by the Undersea and Hyperbaric Medical Society (1) and listed below:

- Air or Gas Embolism
- Carbon Monoxide Poisoning
- Carbon Monoxide Poisoning Complicated By Cyanide Poisoning
- Clostridial Myositis and Myonecrosis (Gas Gangrene)
- Crush Injury, Compartment Syndrome and Other Acute Traumatic Ischaemias
- Decompression Illness
- Arterial Insufficiencies:
- Central Retinal Artery Occlusion
- Enhancement of Healing In Selected Problem Wounds
- Severe Anaemia
- Intracranial Abscess
- Necrotizing Soft Tissue Infections
- Osteomyelitis (Refactory)
- Delayed Radiation Injury (Soft Tissue and Bony Necrosis)
- Compromised Grafts and Flaps
- Acute Thermal Burn Injury
- Idiopathic Sudden Sensorineural Hearing Loss

In addition to providing a 24 hour on-call service, the hyperbaric unit offers treatments on weekdays for elective patients.

Development of the hyperbaric service to present day

Diving casualties were originally treated in the recompression chambers in HMS Vernon when it was the home of the Royal Navy Diving School. The Royal Naval Physiological Laboratory research facility in Alverstoke had provided the recompression service during Royal Navy leave periods and, when HMS Vernon faced closure, RNPL took on full-time responsibility for the service.

Hyperbaric oxygen therapy has been used for treatment of a range of non-diving emergencies such as carbon monoxide poisoning and gas gangrene. Anaesthetists from Royal Hospital Haslar provided care for the critically-ill patients in the chambers but the logistic and medical shortcomings made this arrangement unsatisfactory. As a result, the hyperbaric medicine unit was opened at Haslar in 1996.

The gradual withdrawal of acute medical services from Haslar, beginning with the closure of the intensive care unit in 1999, made treatment of acutely ill patients increasingly difficult so a portable Type B chamber, loaned from the Royal Navy, was installed at Queen Alexandra Hospital in Cosham. This allowed hyperbaric treatment of critically ill and emergency patients.

In July 2001 MOD passed ownership of a wide range of assets related to military maritime support to the newly-vested QinetiQ. This included the chamber and its staff. These assets are now made available to MOD through the Maritime Strategic Capability Agreement. This contract provided funding for the transfer of the...
Hyperbaric Medicine Unit in anticipation of the closure of Royal Hospital Haslar in July 2009. MOD assessed the options submitted by interested parties and chose St Richard’s Hospital in Chichester as the new home for the unit.

While the new unit was under construction, continuity of an emergency recompression service for MOD was maintained by moving the containerised Type B chamber at Cosham to Chichester. There were no incidents requiring use of the Type B chamber in that period.

The original large chamber from Haslar was craned into its newly-built home in St Richard’s Hospital on 10 October 2009. Contractors and QinetiQ’s own staff then worked hard to recommission the chamber over the following months. The unit was operational for treatment of MOD divers by January 2010. Vice Admiral Ibbotson, Deputy Commander-in-Chief Fleet, officially opened the chamber on 2 March 2010. The unit gained registration with the Healthcare Commission (now the Care Quality Commission) on 23 April 2010.

Between April 1995 and July 2009, more than 4000 patient-treatments were administered to over 1000 patients. Although some of this activity took place at Alverstoke and the satellite unit at Queen Alexandra Cosham, the vast majority were at Haslar.

### Calendar Year and Number of Exposures

<table>
<thead>
<tr>
<th>Calendar Year</th>
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<tbody>
<tr>
<td>1995</td>
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**Table 2: Number of hyperbaric exposures with in-chamber ventilation**

The numbers of critically-ill patients, most of whom were victims of carbon monoxide poisoning, have fallen for a number of reasons. The incidence of carbon monoxide poisoning has reduced following introduction of catalytic converters for petrol engines and tougher enforcement of regulations requiring landlords to ensure that gas boilers are serviced regularly. Also, conflicting research findings regarding the value of hyperbaric oxygen therapy introduced some doubt about the justification for referral for, and funding of, the treatment (2,3).

Finally, since the closure of the Intensive Care Unit in Royal Hospital Haslar, it has become increasingly difficult to maintain a continuous rota of anaesthetists / intensivists who are prepared to care for patients in the chamber.

### Current situation

The newly-established unit has an excellent location in the hospital, close to the Accident and Emergency Department, Medical Assessment Unit and Intensive Care Unit. There is a landing site large enough for coastguard helicopters next to the hospital grounds.

The chamber was originally a Royal Navy Type A two compartment diving chamber with access through circular hatches. An arched doorway has been added to the main chamber. This makes access easier for patients in a wheelchair or on a trolley and for others with mobility problems. The main compartment has an environmental control unit to regulate temperature and humidity and to remove carbon dioxide. There are supplies of compressed oxygen, air and 50% oxygen in helium, allowing the chamber to conduct all current Royal Navy therapeutic tables.

The unit is a Category 1 hyperbaric facility as described in the Cox Report and is registered as a Level 1 hyperbaric facility with the Care Quality Commission. This means that the chamber can accommodate critically-ill patients for hyperbaric

### Categories of Patients Treated

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<th>Category</th>
<th>Patients treated</th>
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<tbody>
<tr>
<td>Carbon Monoxide</td>
<td>270</td>
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<tr>
<td>Diving</td>
<td>541</td>
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<tr>
<td>Elective other</td>
<td>194</td>
</tr>
<tr>
<td>Emergency other</td>
<td>36</td>
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</tbody>
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**Table 1: Categories of patients treated from April 1995 to July 2009.**

239 of the exposures (for 98 patients) required ventilation. Most of these were to treat casualties of carbon monoxide poisoning – Table 2.
treatment. It has equipment such as ventilators, monitors and syringe drivers suitable for use in a hyperbaric environment, but will accept a patient who requires critical care, or who is reasonably expected to deteriorate and require critical care only if the in-chamber attendance of anaesthetic or intensivist medical staff can be arranged prior to the treatment.

QinetiQ provides technical staff, a Medical Director, a registered paramedic and hyperbaric nurses. The Institute of Naval Medicine provides medical officers with hyperbaric expertise. The host hospital trust (Western Sussex Hospitals NHS Trust) provides support to care for patients before, between and after hyperbaric treatments.

Since opening, the new unit has treated 34 cases of decompression illness with 40 patient-pressurisations. 29 more patients have undergone 402 patient-pressurisations for treatment of other acute and chronic conditions or as participants in the HOT II multi-centre clinical trial which is investigating the benefit of hyperbaric oxygen therapy for radiation proctitis (4).

The HOPON multi-centre trial, investigating the role of hyperbaric oxygen in prevention of osteoradionecrosis, has just opened in the unit but no-one has been recruited to date (5). Most of the elective patients attend for treatment of compromised wounds or late radiation tissue injury. These are the indications in which we tend to see the most successful outcomes and for which the most persuasive evidence has accumulated so far.

The elective patients allow medical officers to become familiar with the chamber and patient safety issues in an unhurried environment. Once these issues become second nature, it allows them to concentrate on more acute aspects of diagnosis and treatment of diving emergencies. In this way, the hyperbaric medicine unit provides an ideal environment for diving medical officers to acquire, to develop and to maintain their competence in treating patients in a recompression chamber. This level of practical experience is invaluable when giving remote advice to others dealing with diving incidents elsewhere.

As a result of the Maritime Strategic Capability Agreement, MOD is unlikely to incur additional treatment costs for UK military elective cases referred to the Chichester hyperbaric unit.

**Future**

The busier the unit, the greater is the opportunity for the chamber to become a centre of excellence for training. The more patients treated and funded (either by commissioning bodies, research bodies, health insurance or through private arrangements), the lower is the net cost to MOD of providing a facility for treating any diving training casualties and maintaining expertise in diving medicine.

For these reasons, the main priority is to ensure that the unit is able to treat the widest possible range of patients who are likely to benefit from hyperbaric oxygen therapy. Participation in good quality clinical research is central to this strategy as it allows us to identify the conditions that benefit from hyperbaric oxygen therapy and can justify NHS funding.

Another high priority is to make progress from the current position where the chamber is able to accommodate critically-ill patients only if the correct staff are available to having appropriate staff on-call so that we have a reliable and continuous capability in that respect. This will increase the range of patients that can be accepted but will also ensure that diving casualties are guaranteed access to prompt recompression however ill they are, rather than depending on which personnel can be made available at any particular time.

The diving medical officers at INM and the medical director of the hyperbaric medicine unit divide the total elective patient and research sessions between them. The incremental benefit for fully trained diving medical officers diminishes with more frequent attendance and, since the number of diving medical officers is declining at INM, there is an opportunity for other service medical officers who are interested in diving and hyperbaric medicine to gain practical experience at this facility. Any RN medical personnel interested in working at the hyperbaric medicine unit should contact the Head of Diving Medicine at INM.

**Reference**

4. HOT II (Randomised double-blind controlled phase III trial of hyperbaric oxygen therapy in patients suffering longterm adverse effects of radiotherapy for pelvic cancer), EudraCT No: 2008-002152-26, ISRCTN No: 86894066
5. HOPON (Hyperbaric Oxygen for the Prevention of Osteoradionecrosis), EUDRACT No: 2007-006225-27, ISRCTN No: 39634732

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Dr M Glover Medical Director, Hyperbaric Medicine Unit, Chichester