

PREVENTION OF DYSBARIC INJURIES IN DIVING AND HYPERBARIC WORK
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Safety management: Hyperbaric therapy aspects

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Hyperbaric oxygen therapy (HBO) is a method of treatment which uses increased pressure and different breathing gases (including 100% oxygen) to treat specific diseases. It is conducted in hyperbaric facilities using multiplace or monoplace chambers.

In hyperbaric medicine many people are involved in the therapeutic process, and therefore clearly defined responsibilities are mandatory. The medical director is responsible for all functions developed in the hyperbaric centre, and for each hyperbaric session the supervisor must be appointed. During any treatment in the multiplace hyperbaric chamber the following functions are involved: supervision of the treatment (medical aspects and safety of operations), operation of the chamber, attendance of patients under pressure, and emergency assistance under pressure if needed. Therefore, the minimum team size is three people: hyperbaric physician, attendant and operator. However, there are situations when more people are needed as depending on patient status. For any treatment in monoplace hyperbaric chambers there is no attendance of patients under pressure, but other functions are generally the same. This allows having only two persons as the minimum team size: hyperbaric physician and chamber operator.

Clinical hyperbaric centres are highly specialized and equipment-dependent medical facilities and therefore they have to deal with additional hazards over and above those in a typical hospital setting. These hazards may affect patients, staff and third parties involved in the therapeutic process. Therefore safety management is very necessary. It must include risk analysis with hazard identification and risk estimation, risk evaluation with risk acceptability decisions, and risk control with option analysis and implementation in order to minimize the residual risk affecting patients and staff.

All types of risks need to be studied including: 1) energy hazards, 2) biological hazards, 3) environmental hazards, 4) hazards related to the use of medical devices, 5) hazards arising from functional failure, maintenance and ageing, 6) dysbaric injuries of the medical attendants. Results of this risk analysis should report any identified hazard and its consequences for the patient, the accompanying personnel and the operators. There are some hazards which are specifically found in the therapeutic hyperbaric facilities including: high pressures and change of pressure; high oxygen content in breathing mixtures and accidentally in chamber atmosphere; quality and quantity of

breathing gas supply; prohibited materials within chamber; electricity; fire; noise; thermal stress; hygiene and infection control; management of body fluids; waste and infected materials; handling of patients; use of medical devices; pressure differentials for medical items (drainages, tubes); decompression of the medical attendants. Whenever elimination of hazard is not possible, the control measures and procedures to minimize the risk should be defined. Based on the risk analysis every hyperbaric facility must define Standard and Emergency Operating Procedures taking into account the type of hyperbaric centre (hospital-based or standalone, multiplace or monoplace chambers), team size, staff education, patient condition, treatment protocols and the medical devices used. All staff should be familiar and regularly retrained with those procedures. The Standard and Emergency Operating Procedures must be included in the facilities Operating Manual which should be reviewed periodically. The documentation of all data related to the facility, the system, and the patients becomes an intrinsic part of the facilities safety management.

From the point of view of occupational hazard for the medical personnel working under pressure, the fitness and health surveillance is one of the most important parts of the safety management for each hyperbaric facility. Even if exposed only occasionally to increased pressure, the medical attendant must undergo an appropriate initial and periodical medical examination to be recognized fit for work-under-pressure (eg. verified pregnancy is a contraindication), and consideration should be given to daily fitness. Change of pressure during compression and decompression, as well as breathing of compressed air or other gas mixtures are hazards for dysbaric injuries for attendant staff: barotraumas or decompression illness/sickness. In order to prevent the risk of hyperbaric exposures for medical attendants the hyperbaric facilities usually adopt a decompression procedures used for work under pressure. This often includes additional safety considerations limiting the number of exposures per person within given period (eg. once per 24 hours), the maximum number of daily exposures without a break (eg. 2-day break after 5 daily exposures) and limitations on flying or travelling in hilly or mountain regions. Moreover staff should receive training in the prevention of dysbaric injuries (eg. hydration, avoiding of heavy exercise after the exposure), recognition of decompression illness/sickness in themselves and others. Recompression treatment must be included in operating procedures of the hyperbaric facility, and all work-under-pressure related illness should be reported according to national regulations. The problem of occupational risk for hyperbaric staff is similar to that for professional divers. Indeed, in the absence of specific national regulations dedicated to hyperbaric centres, other standards used by divers at work are usually implemented.

The role of medical attendant inside the hyperbaric chamber is care of the patients including those critically ill. Therefore status of the patient has indirect effect on occupational hazard for medical staff of the hyperbaric facility. Any prolongation of hyperbaric treatment or shortening in case of emergency (eg. need for defibrillation) can increase the risk of decompression illness/sickness of the personnel, and procedures must be prepared, including for example staff rotation inside chamber.

In summary, there are many common topics between hyperbaric oxygen therapy and diving activities including: increased and changing pressure, different breathing gases, decompression procedures, risk of dysbaric injuries. In both activities a number of staff is needed to complete the task and therefore each member of the team should understand his/her duties and hierarchy of responsibility must be clearly defined. During hyperbaric exposition as well as during diving there is a risk of dysbaric injuries, and precautions must be taken. In both activities similar reporting system for occupational hazards and work related injuries should be implemented. Standard and emergency procedures must be prepared and trained by the whole staff. On the other hand, there are also many factors which differentiate hyperbaric oxygen therapy and diving activity including: personal equipment, environmental conditions, underlying pathology of patient's illness, use of medical devices, etc.

In conclusion, safety management for hyperbaric oxygen therapy – regardless of being conducted using a similar algorithm as for diving operations – must be performed specifically for this kind of treatment taking into account also status of patient and medical devices used.

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NOTE: The opinion of the author is complementary with a "Code of Good Practice in Hyperbaric Oxygen Therapy", which is a document in preparation by the Working Group "Safety" of the COST B14 action "Hyperbaric Oxygen Therapy". Details are presented at: www.oxynet.org.