factors for poor outcome are age >35 years, exposure for >24 h, acidosis, and loss of consciousness.

Clinical Evidence The typical course of HBO_2T consists of two to three compressions to 2–2.8 ATA for 1.5–2 h each session. It is common for the first two compressions to be delivered within 24 h of the exposure. CO poisoning is one of the longest-standing indications for HBO_2T—based largely on the obvious connection between exposure, tissue hypoxia, and the ability of HBO_2T rapidly to overcome this hypoxia. CO is eliminated rapidly via the lungs on application of HBO_2T, with a half-life of about 21 min at 2.0 ATA versus 5.5 h breathing air and 71 min breathing oxygen at sea level. In practice, however, it seems unlikely that HBO_2T can be delivered in time to prevent either acute hypoxic death or irreversible global cerebral hypoxic injury. If HBO_2T is beneficial in CO poisoning, it must reduce the likelihood of persisting and/or delayed neurocognitive deficit through a mechanism other than the simple reversal of arterial hypoxia due to high levels of COHb. The difficulty in accurately assessing neurocognitive deficit has been one of the primary sources of controversy surrounding the clinical evidence in this area. To date there have been six randomized controlled trials of HBO_2T for CO poisoning, although only four have been reported in full. While a Cochrane review suggested that overall there is insufficient evidence to confirm a beneficial effect of HBO_2T on the chance of persisting neurocognitive deficit following poisoning (34% of patients treated with oxygen at 1 atmosphere vs 29%, of those treated with HBO_2T; odds ratio [OR] 0.78; 95% CI 0.54–1.1), this may have more to do with poor reporting and inadequate follow-up than with evidence that HBO_2T is not effective. The interpretation of the literature has much to do with how one defines neurocognitive deficit. In the most methodologically rigorous of these studies (Weaver et al.), a professionally administered battery of validated neuropsychological tests and a definition based on the deviation of individual subtest scores from the age-adjusted normal values was used; if the patient complained of memory, attention, or concentration difficulties, the required decrement was decreased. Using this approach, 6 weeks after poisoning, 46% of patients treated with normobaric oxygen alone had cognitive sequelae compared to 25% of those who received HBO_2T (p = .007; number needed to treat [NNT] = 5; 95% CI 3–16). At 12 months, the difference remained significant (32% vs 18%; p = .04; NNT = 7; 95% CI 4–124) despite considerable loss to follow-up.

On this basis, HBO_2T remains widely advocated for the routine treatment of patients with moderate to severe poisoning—in particular in those older than 35 years, presenting with a metabolic acidosis on arterial blood-gas analysis, exposed for lengthy periods, or with a history of unconsciousness. Conversely, many toxicologists remain unconvinced about the place of HBO_2T in this situation and call for further well-designed studies.

DIVING MEDICINE

INTRODUCTION

Underwater diving is both a popular recreational activity and a means of employment in a range of tasks from underwater construction to military operations. It is a complex activity with unique hazards and medical complications arising mainly as a consequence of the dramatic changes in pressure associated with both descent and ascent through the water column. For every 10.13 m increase in depth of seawater, the ambient pressure (P_{amb}) increases by 101.3 kPa (1 atmosphere) so that a diver at 20 m depth is exposed to a P_{amb} of approximately 303.9 kPa (3 ATA), made up of 1 ATA due to atmospheric pressure and 2 ATA generated by the water column.

BREATHING EQUIPMENT

Most diving is undertaken using a self-contained underwater breathing apparatus (scuba) consisting of one or more cylinders of compressed gas connected to a pressure-reducing regulator and a demand valve activated by inspiratory effort. Some divers use "rebreathers," which are scuba devices that are closed or semiclosed circle systems with a carbon dioxide scrubber and a system designed to maintain a safe inspired PO_2. Exhaled gas is recycled, and gas consumption is limited to little more than the oxygen metabolized by the diver. Rebreathers are therefore popular for deep dives where expensive helium is included in the respired mix (see below). Occupational divers frequently use "surface supply" equipment where gas, along with other utilities such as communications and power, is supplied via an umbilical from the surface.

All these systems must supply gas to the diver at the P_{amb} of the surrounding water or inspiration would be impossible against the surrounding water pressure. For most recreational diving, the respired gas is air. Pure oxygen is rarely used because oxygen may provoke seizures above an inspired PO_2 of 162 kPa (1.6 ATA) in aquatic environments, limiting the practical safe depth to 6 m. This is a conspicuously lower PO_2 than routinely used for hyperbaric therapy, reflecting a higher risk of both seizures and pulmonary toxicity during immersion. For the same reason, very deep diving requires the use of oxygen fractions lower than in air (FO_2 0.21). This is because breathing air at 66 m means inspiring 1.6 ATA of oxygen, the maximum allowable pressure. To dive any deeper, breathing gases must contain less oxygen than air. Deep-diving gases often include helium instead of nitrogen to reduce both the narcotic effect and high gas density that result from breathing nitrogen at high pressures.

SUITABILITY FOR DIVING

The most common reason for physician consultation in relation to diving is for the evaluation of suitability for diver training or after a health event. Occupational diver candidates are usually compelled to see doctors with specialist training in the field, both at entry to the industry and periodically thereafter, and their medical evaluations are usually conducted according to legally mandated standards. In contrast, in most jurisdictions prospective recreational diver candidates simply complete a self-assessment medical questionnaire prior to diver training. If there are no positive responses, the candidate proceeds directly to training, but positive responses mandate the candidate see a doctor for evaluation of the identified medical issue. Prospective divers will often present to their family medicine practitioner for this purpose. In the modern era, such consultations have evolved from a simple proscriptive exercise of excluding those with potential contraindications to a more "risk analysis" approach in which each case is evaluated on its own merits. Such analyses require integration of diving physiology, the impact of associated medical problems, and a detailed knowledge of the specific medical condition of the candidate. A detailed discussion of the subject is beyond the scope of this chapter, but a few important principles are outlined below.

There are three primary questions that should be answered: (1) Could the underlying condition be exacerbated by diving? (2) Could the condition make a diving medical problem more likely? (3) Could the condition prevent the diver from meeting the functional requirements of diving? As examples, epilepsy is usually considered a contraindication because there are epileptogenic stimuli encountered in diving that could make a seizure more likely (such as thermal stress and exercise). Active asthma is a relative contraindication because it could predispose to pulmonary barotrauma (see below), and untreated ischemic heart disease is a contraindication because it could prevent a diver from exercising sufficiently to get out of a difficult situation such as being caught in a current. It can be a complex matter to recognize the relevant interactions between diving and medical conditions and to determine the impact on suitability for diving. Physicians interested in regularly conducting such evaluations should obtain relevant training. Short courses providing relevant training are offered by specialist groups in most countries.

BAROTRAUMA

The problem of middle-ear barotrauma (MEBT) with diving is similar to the problem that may occur during descent from altitude in an airplane, but difficulties with equalizing pressure in the middle ear are exaggerated underwater by both the rapidity and magnitude of pressure change as a diver descends or ascends. Failure to periodically insufflate the middle-ear spaces via the eustachian tubes during descent results in increasing pain. As the P_{amb} increases, the tympanic membrane (TM)