

## Hyperbaric oxygen pretreatment and preconditioning

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### ABSTRACT

Exposure to hyperbaric oxygen (HBO<sub>2</sub>) before a crucial event, with the plan to create a preventing therapeutic situation, has been defined “preconditioning” and is emerging as a useful adjunct both in diving medicine as well before ischemic or inflammatory events. Oxygen pre-breathing before diving has been extensively documented in recreational, technical, commercial and military diving for tissue denitrogenation, resulting in reduced post-diving bubble loads, reduced decompression requirements and more rapid return to normal platelet function after a decompression. Preoxygenation at high atmospheric pressure has also been used in patients before exposure to clinical situations with beneficial effects, but the mechanisms of action have not yet

been ascertained. During the reperfusion of ischemic tissue, oxygenated blood increases numbers and activities of oxidants generated in tissues. Previous reports showed that HBO<sub>2</sub> preconditioning caused the activation of antioxidative enzymes and related genes in the central nervous system, including catalase (CAT), superoxide dismutase and heme oxygenase-1. Despite the increasing number of basic science publications on this issue, studies describing HBO<sub>2</sub> preconditioning in the clinical practice remain scarce. To date, only a few studies have investigated the preconditioning effects of HBO<sub>2</sub> in relation to the human brain and myocardium with robust and promising results.

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### RATIONALE

Preoxygenation by breathing elevated concentrations of oxygen (O<sub>2</sub>) before an event has been documented to induce various effects that mirror the physiologic and therapeutic applications demonstrated both in extreme environments and in selected clinical applications. In the most trivial form, 100% oxygen prebreathing has been used to extend useful apnea time during breath-hold diving and to denitrogenate the lungs and other tissues before flights at very high altitudes or even before extravehicular activities (EVA) in space at reduced ambient pressure. A clinical counterpart is a recommended safety maneuver to extend safe intubation time after rapid induction of anesthesia and muscle paralysis, allowing prolonged laryngoscopy exposure time for tracheal intubation, especially in patients at risk of rapid desaturation following apnea such as pregnant women, small children and the obese.

### Diving medicine applications

It has been exhaustively documented that oxygen exposure can be successfully utilized for recreational, technical, commercial [1] and military diving [2]. Among the clinical conditions that can be treated with oxygen therapy, decompression sickness (DCS) is one of the most common complications [3].

HBO<sub>2</sub> and normobaric oxygen (NBO<sub>2</sub>) prebreathing maneuvers have been shown to be beneficial in preventing or reducing air bubble formation and platelet activation after a given dive profile, thus reducing the development of DCS [4,5]. Bosco and colleagues demonstrated that in-water O<sub>2</sub> prebreathing at a depth of 6 or 12 msw led to lower bubble scores than prebreathing O<sub>2</sub> at the surface in open-water sea divers after a set dive exposure [5]. The HBO<sub>2</sub> preconditioning procedure for denucleation may have a potential application in decreasing the DCS risk in humans. In addition, the authors showed that pre-