

## OXYGEN TOXICITY

The effects of oxygen are increased at depth. The maximum PO<sub>2</sub> advised in diving is 1.6ATA. This oxygen level is achieved at 231 fsw breathing air, 13 fsw breathing 32% O<sub>2</sub>, and 20 fsw breathing 100% O<sub>2</sub>.

Oxygen molecules in high enough numbers can cause brain cells to fire off. A massive random discharge of brain cells results in a seizure or convulsion. At depths greater than 20 fsw (feet of sea water), pure oxygen (100%) can cause divers to convulse. This is due to the effects of Dalton's Law which states that on descent, the partial pressure of all component gases increase in the same ratio as the total pressure. This results in the creation of the large number of oxygen molecules as one goes deeper (elevated pO<sub>2</sub>) that causes the convulsions of O<sub>2</sub> toxicity. This is also the direct cause of nitrogen narcosis (due to increased numbers of nitrogen molecules in the tissues), and along with Boyle's law, is the cause of decompression sickness, but that's another topic.

Medical treatments using hyperbaric 100% O<sub>2</sub> treatments are given at 60 feet or shallower and the patients are at rest to minimize the risk of oxygen seizures. Divers, on the other hand, are active and subject to other variables increasing the possibility of seizures. Therefore, the use of pure (100%) oxygen is limited to dives of 20 fsw or less. For these same reasons, the use of 'nitrox' (compressed gas mixtures with greater than 21%) by 'tech' divers has definite depth limits imposed. Special training to use these oxygen enriched gas mixtures is required to focus on these depth limits and the dangers involved.

The effect on the central nervous system ( the Paul Bert effect), can result in:

- muscle twitching and spasm, notably facial muscles
- nausea and vomiting
- dizziness
- vision (tunnel vision) and hearing difficulties (tinnitus)
- irritability, confusion, anxiety and a sense of impending doom
- trouble breathing,
- unusual fatigue
- incoordination
- convulsion.

Unfortunately, these symptoms and signs may not occur in any particular sequence, and can occur with little or no warning. Also, people differ in their susceptibility to oxygen toxicity. Convulsions at depth in water usually results in drowning or arterial gas embolism.

Factors increasing susceptibility to O<sub>2</sub> toxicity include:

- Increasing exposure time
- Increasing depth
- Increasing the percentage of inspired O<sub>2</sub> (As in nitrox mixtures)
- The simple act of immersion setting off the diving reflex
- Exercise increasing the metabolic rate
- Increased CO<sub>2</sub> in the tissues (May be due to cerebral vasodilation)
- Cold stress (Shivering is a form of exercise)
- Systemic diseases that increase the metabolic rate (such as thyroid diseases)

Another manifestation of oxygen toxicity is the effect that it has on the lungs over a period of time. Pulmonary oxygen toxicity ( Lorraine Smith effect) is a direct time/dose relationship on the lungs. This is caused by a direct effect of O<sub>2</sub> on the lungs leading to decreased pulmonary function. Pulmonary oxygen toxicity is best prevented by limiting exposure and removal of pure O<sub>2</sub> at the first signs of toxicity.

Fortunately, recreational divers will rarely run the risk of lung problems unless perhaps they are being treated for resistant decompression sickness. Sport divers are also able to avoid seizures and central nervous system oxygen toxicity by not using oxygen with SCUBA and by limiting depths on enriched nitrogen/oxygen mixtures (Nitrox).