NEW HORIZONS IN HYPERBARIC OXYGENATION

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The use of oxygen at increased atmospheric pressure in the post war years followed clinical research in the 1930's which established the role of hypoxia in a variety of conditions. An increase in the effectiveness of radiation therapy on cultures of cancer cells found using hyperbaric oxygenation was not reflected in clinical experience. The prolongation of the duration of cardiac arrest without brain damage using increased oxygenation became academic with the development of cardiopulmonary bypass procedures. After a period of inactivity there is increasing recognition of the need for hyperbaric oxygenation for conditions not amenable to pharmacological intervention.

BAROMETRIC PRESSURE AND OXYGEN TENSION

The sole determinant of the rate of oxygen transport into tissue is the tension of the gas in plasma. Assuming normal pulmonary function, breathing air at sea level when barometric pressure is a standard atmosphere of 1013 hPa oxygen exerts a pressure of 212 hPa. This gives a plasma tension of about 133 hPa in healthy individuals. Atmospheric pressure varies with the weather and therefore the plasma tension also changes. The lowest pressure recorded at sea level in the UK has been 905 hPa, corresponding to an oxygen partial pressure of 189 hPa. On a high pressure day, where the atmospheric pressure can exceed 1050 hPa more oxygen enters the body and is one factor responsible for the sense of well-being in a period of good weather.

Barometric pressure is not considered in clinical practice, but is of critical importance in aerospace and diving activity. In space exploration the suits used are pressurised to about one third of normal atmospheric pressure and the astronauts breathe pure oxygen. Commercial aircraft are hyperbaric chambers, although at altitude the cabin pressure is subatmospheric causing hypoxia in some passengers. Concorde which flies at altitudes over 60,000 feet has a test pressure in excess of an atmosphere. In diving the World record
stands at 523 metres and a breathing mixture consisting of helium, hydrogen and about 1% oxygen was used, graphically illustrating that it is the partial pressure of oxygen that is important not the percentage. Thousands of scientists and engineers have been involved in this technology, but only a small number of physicians. They understand the effects of pressure, the dangers of oxygen deficiency and the use of oxygen at dosages far higher than those normally possible in hospital. The concept of dosage is critical to the acceptance of oxygenation under hyperbaric conditions.

HYPOXIA AND MIXED GAS DIVING

The emergence of the offshore oil and gas industry and the rapid expansion of commercial saturation diving has involved a group of physicians who now have experience of hyperbaric technology and its associated problems. It has brought a new awareness of hyperbaric oxygenation. Whenever artificial breathing mixtures are made there is the possibility that sufficient oxygen may not be included. Over 16 deaths have occurred in commercial diving over the last twenty years because of this problem which leads to anoxic asphyxia. Nothing illustrates the dependency of the brain on the presence of oxygen in the respired gas more than the effect of breathing a pure gas such as helium, but the effect is seen with any gas other than oxygen. Helium is used routinely in commercial diving beyond 50 metres of sea water and is usually supplied premixed with oxygen to offshore diving operations. However gas blenders are also used which allow oxygen to be mixed with helium during diving. If the oxygen supply runs out then pure helium is supplied to a diver and loss of consciousness occurs within a few breaths. This is because the oxygen in the blood of the central venous return supplied to the lungs diffuses out into the respired gas because of the concentration gradient. The lungs can therefore transport oxygen in either direction with equal facility and do not use active transport as originally suggested by JS Haldane.

Acute hypoxaemia is associated with rapid loss of consciousness and if sustained leads to vasodilatation and failure of the energy-dependent endothelial mechanisms responsible for the blood brain barrier, increasing vascular permeability. Cerebral oedema creates further hypoxia and a further increase in permeability and free radicals are released which initiate lipid peroxidation. These effects are initially reversible by oxygen under hyperbaric conditions. In diving using a bell and transfer under pressure to chambers on deck it is possible to give a large dosage of oxygen quickly which may be life saving, but, at the moment few hospitals are equipped with hyperbaric chambers. There is clearly no substitute for oxygen and Taylor has drawn attention to the economics of hypoxia. “Clearly the cost of a few extra days in an ICU to prevent a hypoxic episode would be a fraction of the amount needed for the long-term care of someone brain damaged as a result of an inadequate blood (oxygen) supply.”

DECOMPRESSION SICKNESS

Decompression sickness is due to the release of inert gas following a reduction of pressure. It can occur as the result of an ascent to altitude or on decompression from a hyperbaric exposure. The uptake and release of inert gas is not symmetrical and cannot be calculated. Even following conservation decompression procedures gas forms in tissue and some may enter the circulation as bubbles. The conventional view that bubbles cause