



## Hyperbaric Oxygen at the Dead Sea

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Summarized here are the proceedings of a workshop held at the Dead Sea on 2 November 2001 under the title "Applications of Hyperbaric Therapy in the Dead Sea Area." This workshop was organized by the Dead Sea Research Center in collaboration with the Unit for Hyperbaric Therapy at the Rambam Medical Center, Haifa.

In his opening remarks Shimon Moses, scientific director of the Dead Sea Research Center, mentioned the unique features of the Dead Sea basin, which, being part of the Syrian-African Rift Valley, represents the lowest spot on the lowest natural plateau at 414 meters below sea level. As a result of the evaporation of the Dead Sea water a layer of mist hangs over the sea. The combination of the low altitude and the mist results in a marked attenuation of the solar ultraviolet radiation. This unique attenuation of the solar ultraviolet waves, which has been studied by Avraham Kudish from the Solar Energy Laboratory of the Ben-Gurion University, has been shown to be of therapeutic value for a number of skin diseases, psoriasis being the most prominent. These climatic conditions, together with the thalasso-therapeutic properties of the unique salt composition of the Dead Sea water and the balneo-therapeutic effects of the sulfur-containing mineral waters, are known to be beneficial for various joint diseases. While these unique properties have been taken advantage of since biblical times, only recently has a scientific basis been established providing insight into the nature of these effects and establishing optimal exposure time and the relative part played by thalasso-therapy relative to solar radiation exposure.

Dr. Kudish presented the results of his ongoing study on the barometric pressure during the various seasons of the year as observed in the Dead Sea basin. From his studies it is apparent that the highest percent increase above normal atmospheric barometric pressure occurs during the winter months and the lowest during the summer months. The monthly changes in barometric pressure can be attributed to the concomitant variations in the ambient temperature that affect the density of the air. It has been accepted that this increased barometric pressure, which is associated with a concomitant elevation of the ambient partial oxygen pressure, can be exploited for a number of diseases. In view of the seasonal changes mentioned above, it turns out that the months most suitable for therapies relating to higher barometric pressures are the winter months.

Yehuda Melamed from the Hyperbaric Medical Unit at Rambam Hospital in Haifa reviewed the physiologic and clinical aspects of the use of hyperbaric oxygen. He presented a detailed description of the effects of hyperoxia on increasing arterial blood oxygenation, which is mainly achieved by increasing the amount of physically dissolved oxygen in the plasma. This offers an intravascular pool of oxygen at high partial pressures that is readily available for diffusion into hypoxic tissues. He also summarized mechanisms by which hyperoxia boosts repair of tissues by augmenting the killing of bacteria, and enhancing angiogenesis, collagen deposition and bone formation.

Avi Shupak from the Israel Naval Medical Institute reviewed the physical and physiologic aspects of exposure to the hyperbaric/hyperoxic environment in the

Dead Sea area, which offers only a 5% increase in the ambient oxygen partial pressure. This leads to only a small increase in the oxygen content of arterial blood. He presented data suggesting that even a small increase in oxygen partial pressure might lead to enhanced gene signaling and up-regulation of intrinsic anti-oxidant mechanisms. These suggested effects may lead to improvement in the ability to cope with pathologic conditions, characterized by augmented production of reactive oxygen species through mechanisms reminiscent of ischemic preconditioning.

Haim Bitterman from Carmel Hospital and the Technion Faculty of Medicine in Haifa summarized the effects of hyperoxia on the cardiovascular system in normal and pathologic conditions. He presented data on the effects of hyperoxia during tissue ischemia, demonstrating that it causes redistribution of blood flow from adequately perfused tissues to areas of ischemia. He also summarized data showing that hyperoxia exerts a profound beneficial effect on local and remote inflammatory microcirculatory changes in ischemia and reperfusion. Some of the beneficial effects of hyperoxia are operative after relatively small increases in ambient oxygen partial pressures.

Noemi Bitterman from the Neaman Institute at the Technion addressed possible implications of increased oxygen pressures on immunologic functions. The main findings point towards a transient immunosuppression (reflected in a decrease in CD4/CD8 ratio in peripheral blood) upon exposure to exaggerated oxygen pressures. Unfortunately there are only a few studies reporting the effects of hyperoxia on the

immune system in patients and especially in diseases with altered immune function (e.g., Crohn's disease, multiple sclerosis). It should also be stressed that most of the available data on the immunologic effects of hyperoxia in healthy volunteers are derived from studies that utilized hyperoxia at partial pressures that are significantly higher than those in the Dead Sea basin.

Eduard Abinader from the Bnei Zion Hospital and the Technion Faculty of Medicine presented a controlled study on the climato-therapeutic effect of the Dead Sea environment on patients with heart disease. Patients showed a decrease in ischemic features and an improvement in exercise capacity, an increase in arterial oxygen saturation, improvement in a subjective sense of well-being, and objectively improved hemodynamics (cardiac output and  $VO_2$  max).

Based on previous studies by Kramer and associates who found that patients with chronic pulmonary disease showed improved oxygenation and exercise performance after a short stay at the Dead Sea,

Asher Tal (from the Ben-Gurion University of the Negev) presented data on 94 cystic fibrosis patients who participated in a rehabilitation winter camp at the Dead Sea, showing a significant improvement of pulmonary function ( $FEV_1$ ) and oxygen saturation that lasted for at least 2 months after their return home. In cohorts of patients studied, all of whom stayed together at the Dead Sea winter camp, no evidence of *Pseudomonas aeruginosa* cross-infection was found.

Gerald M. Fraser and Yaron Niv from the Rabin Medical Center and Tel Aviv University's medical school presented a pilot study on the effects of the Dead Sea environment in Crohn's disease. They showed that a 2 week stay exerted beneficial effects on disease activity and healing of perianal lesions, which enabled a reduction in medications, particularly the dose of steroids.

Ishi Lev and Nachom Gal from the Assaf

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HBO = hyperbaric oxygen

Harofeh Medical Center presented the most recent information on minimal hyperbaric oxygen treatments for cerebral palsy patients. Accumulated data based on numerous anecdotal reports and pilot studies claimed that HBO 100% oxygen at 1.5–2 ATA for 60–90 minutes is a valuable treatment affecting not only motor activity but also improved speech and other cognitive abilities. SPECT (single photon emission computer tomography) is used to prove the beneficial effects of HBO, including a marked increase in metabolism, after HBO treatments, in the areas of the brain thought to be inactive in children with cerebral palsy. The question whether the minimal hyper-oxygenation present at the Dead Sea can produce a positive affect on the brains of these individuals has to be studied.

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