HYPERBARIC OXYGEN AND STROKE RESEARCH

Akimov, G.A. et al. "Assessment of the Efficiency of Hyperbaric Oxygenation Therapy in Early Forms of Cerebrovascular Disorders." NEUROSCI BEHAV PHYS, l985; 15: 13 - 16.

We present results of the assessment of the efficiency of hyperbaric oxygenation therapy in 104 patients with cerebrovascular diseases. Of these patients, 32 had chronic cerebrovascular insufficiency and 72 showed transient disturbances of the cerebral circulation. A good effect was noted in 74 patients, a satisfactory one in 22, and a doubtful one in 8 patients. It is concluded from clinical, electro-physiological, psychophysiological, biochemical, and ophthalmoscopic examinations that hyperbaric oxygenation therapy is quite efficient when used as part of a combined therapy and as a means of prompt therapy of acute cerebrovascular crises. Observations over three to five years of patients repeatedly receiving the hyperbaric oxygenation therapy at 6 month intervals allows us to recommend it for the prevention of cerebral strokes.

Berrouschot, J. et al."Hyperbaric oxygen therapy (HBO) after acute focal cerebral ischemia." NERVENARZT, 1998, 69(12): 1037-44.

For a large number of patients with stroke, no therapeutic option can be offered, even after approval of thrombolytic therapy for treatment of acute ischemic stroke in the U.S. In cerebral ischemia local anoxia and energy failure lead to further cellular damage and finally to complete stroke. All therapeutic concepts try to salvage structurally intact tissue which is at risk for irreversible damage (so-called penumbra). Hyperbaric oxygen (HBO) treatment has been reported in animal models of cerebral ischemia, and in a few clinical reports. In general, the results of these studies have been promising.

Hart, G.B. et al. "The Treatment of Cerebral Ischemia with Hyperbaric Oxygen (OHP)." STROKE, l971; 2: 247-250.

The treatment of a patient for three and one-half months, following occlusion of the right middle cerebral artery with the associated neurological sequelae, with hyperbaric oxygen combined with methyldopa and hydrochlorthazide is presented. Treatment scheduled was two and one-half atmospheres absolute. The treatment was interrupted after 15 treatments to rule out spontaneous remission for a period of 30 days, and no further improvement occurred until treatments were reinstituted. The dramatic return to a near normal state during treatment appears to indicate that he did benefit from therapy.

Heyman, A. et al. "The use of Hyperbaric Oxygenation in the Treatment of Cerebral Ischemia and Infarction." CIRCULATION, Supplement 2: May, l966; 20- 27.

The therapeutic usefulness of hyperbaric oxygenation in cerebral vascular disease was evaluated in 22 persons with recent neurologic deficits caused by cerebral embolism, thrombosis, hemorrhage, or arteriographic complications. Hyperoxygenation produced a significant elevation in content and tension of oxygen in blood and increased the reservoir of oxygen available for utilization by neurons. Remarkable and dramatic improvement in neurologic function occurred in four patients. In two others the neurologic deficit recurred a few hours after removal from the hyperbaric chamber; repeated exposure to high oxygen pressures was associated with only temporary improvement. In six other patients there was some evidence of clinical recovery immediately after onset of hyperoxygenation, but the neurologic deficit returned during decompression. The remaining 12 patients did not improve during hyperbaric oxygenation.

These observations indicate that in some patients neuronal structures remain viable for some hours after loss of function in acute cerebral ischemia. In such instances an increase in oxygen delivery may reverse cellular ischemia and prevent death of cerebral tissues. Hyperbaric oxygenation may provide supportive therapy in some patients with acute cerebral ischemia, thereby permitting the removal of the occlusive lesion by surgery or other methods.

Holbach, K. H. et al. "Neurological and EEG Analytical Findings in the Treatment of Cerebral Infarction with Repetitive Hyperbaric Oxygenation." PROCEEDINGS OF THE SIXTH INTERNATIONAL CONGRESS ON HYPERBARIC MEDICINE, Aug. 31 - Sept. 2, l979, University of Aberdeen, Aberdeen, Scotland, pp. 205-210; George Smith DSC, MD (Ed), Aberdeen University Press, l979.

"...These findings indicate that unilateral occlusion or stenosis of the internal carotid or middle cerebral artery can lead to distinct focal neurological deficits and EEG alterations as well as to bilateral reduction of cerebral function and EGA (electrical brain activity). It also appears that such ischemic alterations of the brain can be improved by HBO therapy not only in the acute but also in the chronic post-stroke stage. Accordingly, we feel that this mode of treatment may be considered as an additional measure in the management of stroke."

Holbach, K. H. et al. "Advantage of Using Hyperbaric Oxygenation (HO) in Combination with Extra-Intracranial Arterial Bypass (EIAB) in the Treatment of Completed Stroke." ACTA NEUROCHIRUGICA, Suppl 28: 309; I979.

"...The evaluation of the effect of HO treatment on post-stroke alterations of the brain can be helpful in differentiating between reversible and irreversible changes, and thus response to HBO treatment may be used as a criterion for the prognosis of the cerebrovascular lesion and also for selection of patients for EIAB surgery."

Holbach, K.H. et al. "Differentiation between Reversible and Irreversible Post-Stroke Changes in Brain Tissue: Its Relevance for Cerebrovascular Surgery." SURG. NEUROL., I977; 7: 325-331.

Thirty-five selected patients with chronic stroke were studied. They had internal carotid occlusion with considerable neurological deficit persisting for an average of ten weeks. First, hyperbaric oxygen treatment was administered to each patient. Subsequently extra-intracranial anastomosis operations were performed on 20 of these patients. These patients were divided into three groups. Group 1 - 15 of the 35 patients - showed a significant improvement of cerebral function at the conclusion of the hyperbaric oxygen treatment. Subsequently an extra-intracranial anastomosis operation was carried out on each patient resulting in considerable further recovery of cerebral functions. Group II consisted of 15 patients who showed only little change in neurological deficit at the conclusion of hyperbaric oxygen therapy. Extra-intracranial anastomosis operations were not carried out in Group II. Group III consisted of five patients with little or no change at the conclusion of hyperbaric oxygen treatment. Subsequent extra-intracranial anastomosis operations were, however, performed in these five patients. Although post-operative angiography revealed considerable filling of the affected middle cerebral territory by the new collateral channel, there was little change in their status. These findings suggest that in the chronic post-stroke stage a) hyperbaric oxygen therapy can improve ischemic alterations of the brain, b) it may be helpful in differentiating between reversible and irreversible alterations of brain tissue, c) extra-intracranial anastomosis may result in additional recovery of impaired neurological functions in those patients who have shown significant improvement from hyperbaric oxygen therapy and d) response to hyperbaric oxygenation may be used as a criteria for selection of patients for cerebral revascularisation procedures.

Holbach, K.H. et al. "Reversibility of the Chronic Post-Stroke State." STROKE, I976; 7(3): 296-300.

Forty patients with cerebral infarction associated with occlusion of the internal carotid artery (ICA) or the middle cerebral artery (MCA) were treated with hyperbaric oxygenation (HO). EEG analysis were performed regularly in order to assess the course of the cerebral lesion. Patients in an early post-stroke stage (IIIB) and patients in a chronic post-stroke stage (IV) had the changes in EEG analysis and neurological findings distributed evenly between these two groups.

In 27% of the cases, the improvement was considerable, 53% had moderate improvement, and 20% showed no change of condition. The improvement mainly consisted of an increase in alpha-wave and beta-wave activity over the affected brain region. We were able to show this fact clearly by means of the EEG-analysis-system applied. The results show that (a) hyperbaric oxygenation therapy (HOT) has a very favorable influence upon the course of disease, and (b) simultaneous application of HOT and EEG analysis allows for a differentiation between reversible and irreversible post-stroke changes in brain tissue.

Ingvar, David et al. "Treatment of Focal Cerebral Ischemia with Hyperbaric Oxygen." ACTA NEUROL. SCANDINAV., I965; 41: 92-95.

Four cases of focal ischemia were treated with inhalation of pure oxygen at a pressure of 2.0 to 2.5 atmospheres ("hyperbaric oxygen") for periods of 1.5 to 2.5 hours. In three of the cases beneficient effects of the treatment were seen which in two of them could be objectively demonstrated in the EEG. In one case with progressive ischemic lesions of the brain stem, treated sub finem, very dramatic effects were seen, which were probably to a great extent due to the effects of the treatment upon the failing systemic circulation.

Jain, K. K. "Chapter 17: Role of Hyperbaric Oxygen Therapy in the Management of Stroke." pp. 227 - 252; in TEXTBOOK OF HYPERBARIC MEDICINE, Hogrefe & Huber Publishers, Lewiston, NY, I990.

"HBO therapy should be started in the acute phase of a stroke as an adjunct to conventional medical management. Rehabilitation of stroke patients should also be planned during the first few months following stroke. Long-term follow-up studies are required to determine whether such measures would reduce the chronic disability from stroke and reduce the incidence of severe spasticity in stroke patients. The use of HBO may also reduce the need for some surgical procedures…Animal experimental studies and uncontrolled human trials have shown the effectiveness and safety of HBO therapy after strokes. At the Fachklinik Klausenbach (FRG) simultaneous HBO and physical therapies were used in the rehabilitation of stroke patients. Objective evaluation of patients during the HBO session showed a 100% response rate (improvement of spasticity or motor power or both). The improvement was initially transient but could be maintained, following a course of daily treatments (1.5 ATA for 45 min.) for 6

weeks, in most of the cases "with the evidence available, it would unethical to carry out randomized double-blind studies in stroke patients to evaluate the effect of HBO therapy".

Jain, K.K. et al. "Hyperbaric Oxygen Therapy in the Rehabilitation of Stroke Patients." 2nd EUROPEAN CONFERENCE ON HYPERBARIC MEDICINE, l990; Organized by the Foundation for Hyperbaric Medicine in Basel and the Department of Surgery of the University Clinic in Basil.

A 100% response rate was demonstrated in 25 patients in sub-acute and chronic post-stroke stage. In spite of medical management and physical therapy, these patients had shown no day-to-day changes in their neurological status. Increase of motor power of the paralyzed hand was demonstrated by a dynamometer. The improvement was transient initially but was maintained following a course of daily treatments (1.5 ATA for 45 min.) for 6 weeks in most of the cases. There was also a significant reduction of spasticity during HBO treatment and this relief could be extended by instituting physical therapy in the chamber. In conclusion, we feel that HBO is a useful adjunctive treatment in the rehabilitation of stroke patients.

Jain, K. K., "Effect of Hyperbaric Oxygenation on Spasticity in Stroke Patients." J Hyperbaric Med, l989; 4(2): 55-61.

The effect of hyperbaric oxygenation (HBO) at 1.5 ATA on spasticity of stroke was observed in 21 patients undergoing rehabilitation. The patients served as their own controls. HBO reduced spasticity in all the patients, an effect that was more marked than that of physical therapy, hyperbaric air, or 100% normobaric air. Initially the effect was transient and subsided within 24 h after treatment, but by conducting physical therapy simultaneously with daily, 45 min HBO sessions, lasting results were achieved after 5 wks and could be maintained by physical therapy alone during the follow-up, which varied from 6 mo. to 1 yr. The exact mechanism of relief of spasticity is not known but it is probably due to improvement of the function of neurons in the penumbra zone of the cerebral hemisphere affected by stroke. This concept is supported by documented improvement of cerebral metabolism, EEG, rCBF, and motor function in stroke patients after HBO therapy. From the available evidence, HBO is considered to be an invaluable adjunct in the rehabilitation of stroke patients with spastic hemiplegia. Although the effects were documented in the paralyzed limbs, spasticity improved in other groups of muscles as well.

Kapp, John. "Neurological Response to Hyperbaric Oxygen - A Criterion for Cerebral Revascularization." SURGICAL NEUROLOGY, l981; 15(1): 43-46.

Twenty-two patients with cerebral infarction secondary to occlusion of a carotid or middle cerebral artery were exposed to hyperbaric oxygen at 1.5 atmospheres absolute pressure. Ten of the patients demonstrated improved motor function during hyperbaric exposure. Seven of these patients had successful surgical revascularization and no recurrence of neurological deficit. In 3 patients who were not successfully revascularized, the neurological deficit recurred. It is concluded that response to hyperbaric oxygen may be of use in the selection of patients with neurological deficit who will benefit from surgical revascularization of the brain.

Lebedev, V.V., et al. "Effect of Hyperbaric Oxygenation on the Clinical Course and Complications of the Acute Period of Ischemic Stroke." ZHURNAL VOPR NEIROKHIRNRY, l983; 3: 37-42.

Hyperbaric oxygenation (HBO) was included in the therapeutic complex for 124 patients in the acute stage of ischemic stroke. The effect of HBO on the clinical course was appraised by comparing the dynamics of changes in the clinical symptoms and the frequency of complications in patients exposed to HBO with those in the control group (patients not exposed to HBO). It was established that the depth of unconsciousness and the motor and aphasic disorders decreased during an HBO session, but the effect was usually short-lived. Aggravation of the patients' condition in the first week of the disease, evidently caused by increase of cerebral edema, occurred much less frequently when HBO was included in the complex of therapeutic measures. The number of patients with regression of the neurological symptoms was practically the same with and without the use of HBO, but the regression of the neurological defects was most evident in patients exposed to HBO. HBO prevents the development of recurrent cerebral circulatory disorders in the acute stage of ischemic stroke and reduces the incidence of some complications in this period (pneumonia, pulmonary edema, thromboembolism of the pulmonary artery, etc).

Marroni, A. et al. "Hyperbaric Oxygen Therapy at 1.5 or 2.0 ATA as an Adjunct to the Rehabilitation of Stabilized Stroke Patients. A Controlled Study." PROCEEDINGS OF THE 9th INTERNATIONAL CONGRESS ON HYPERBARIC MEDICINE, March 1-4, l987; Sydney, Australia, pp. 161-167.

HBO Therapy has been studied by many authors as an adjunctive treatment for stroke patients. Satisfactory results have been reported for the use of HBO as a predictive tool for EC-IC revascularization. The questions of the appropriate treatment pressure has been debated in the literature.

We studied a group of 80 well stabilized cerebral thrombosis patients not any more undergoing any form of treatment or care. Average age was 59.7 yrs., average stroke age 29.2 months. The patients were divided into 8

groups: A: control group not undergoing any care; B: in water rehabilitation, 30 sessions, no HBO; C1: 30 HBO sessions at 2.0 ATA; C2: same at 1.5 ATA; D1: HBO at 2 ATA plus rehabilitation as above; D2: same at 1.5 ATA; E1: HBO and simultaneous rehabilitation in our specially built Hyperbaric pool at 2 ATA; E2: same at 1.5 ATA.

The Rehabilitation protocol was originally developed at our Center as well as a quantitized and repeatable Neuromotor Disability Evaluation Scale. Patients were controlled prior to beginning, every 10 days during treatment, then 1 and 3 months after.

Obtained data show defined and similar HBO effects on the improvement of patients' performance at 1.5 and 2.0 ATA, a clear and significant potentiation of this effect being evident for the Hyperbaric Rehabilitation groups and especially for the group treated at 2.0 ATA. The obtained results were still present at the third month after treatment.

Neubauer, R.A. et al. "Cerebral oxygenation and the recoverable brain." NEUROL RES, 20 Suppl 1: S33-6, 1998.

Oxygenation is the most critical function of blood flow and a sudden reduction in oxygen availability is an inevitable consequence of severe ischemia. The resulting cascade of events may result in the failure of membrane integrity of some cells and necrosis, but in the surrounding zone of tissue, less affected by hypoxia, cells survive to form the ischemic penumbra. The timing of these events is uncertain, but sufficient oxygen is available to these cells to maintain membrane ion pump mechanisms, but not enough for them to generate action potentials and therefore function as neurons. The existence of such areas has been suspected for some time based upon the natue of clinical recovery, but has now been demonstrated by SPECT imaging with a high plasma oxygen concentration under hyperbaric conditions as a tracer. A course of hyperbaric oxygen therapy frequently results in a permanent improvement in both flow and metabolism. These changes apparently represent a reversal of the changes that render neurons dormant and the activity of cells, previously undetectable by standard electrophysiological methods, can now be demonstrated. Three patients are presented in whom recoverable brain tissue has been identified using SPECT imaging and increased cerebral oxygenation under hyperbaric conditions. Improved perfusion from reoxygenation has correlated with clinical evidence of benefit especially with continued therapy.

Neubauer, R.A. et al. "Hyperbaric Oxygen and Imaging Techniques in Diagnosis and Therapy of Stroke. Does the Ischemic Penumbra Alter the Outcome in Stroke?" INTERNATIONAL SYMPOSIUM: NEUROPSYCHOMOTOR, NEURO-PHARMACOLOGICAL, PSYCHOSOCIAL AND ETHICAL ASPECTS, Oct. 7-11, l992; Siracusa, Italy. pp. 1-9.

Recovery from stroke (a global phenomena) and predictability of outcome may be directly related not only to tissue damage, but also the ischemic penumbra or surrounding zone of idling neurons. The local and global effects of stroke are well known. Actual recovery or evolution in the neuronal tissue may go on for months. All events related to recovery have yet to be elucidated. It is known that recovery of ischemic or hypoxic tissue is more related to the oxygen content than to blood flow. Utilization of Single Photon Emission Computerized Tomography (SPECT) with the radiotracer Iofetamine I123, aids in demonstrating ischemic penumbras (reperfusion amplitudes) in strokes, thus lending support to the work of Symon, Astrup and Holbach. SPECT analysis before and after a single exposure of hyperbaric oxygen at 1.5 ATA for 60 minutes was performed on 15 stroke patients with strokes ranging in time from 6 hours to 15 years. In all of these patients marked changes in flow and metabolism were seen after hyperbaric intervention, even in cases with neurologic defects present for up to 15 years. This causes speculation as to when stroke is really completed or fully evolved and whether the standard methods of treatment of stroke, and, by extension, all brain injury, encompass the full understanding of the hypoxic or ischemic penumbra. Five cases are presented here: 4 showed varying degrees of improvement associated with a viable halo zone. One patient demonstrated an absent ischemic penumbra. A new protocol combining HBO and surface oxygen will be suggested.

Neubauer, R. et al. "Enhancing idling neurons." letter. THE LANCET, March 3, l990; 542.

"After HBO there was a sharp increase in tracer uptake in areas showing hypometabolism on the pre-HBO study...Reduced spasticity, improved ambulation and speech, and cessation of drolling were noted."

Neubauer, R. et al. "Stroke Treatment." (letter). THE LANCET, June 29, l991; 1601.

"Hyperbaric oxygen (HBO) efficiently increases the diffusional driving force for oxygen, thereby increasing tissue oxygen availability. This overcomes ischemia/hypoxia and so reduces cerebral edema, restores integrity to the blood/brain barrier and cell membranes, neutralizes toxic amines, promotes phagocytosis, scavenges free radicals, stimulates angiogenesis, and reactivates idling neurons."

Neubauer, R. et al. "Delayed Metabolism or Reperfusion in Brain Imaging after Exposure to Hyperbaric Oxygenation - A Therapeutic Indicator?" PROCEEDINGS OF THE XV ANNUAL MEETING OF THE

EUROPEAN UNDERSEA BIOMEDICAL SOCIETY, Sept. 17-21, l989; Eilat, Israel, pp.1-5.

Single Photon Emission Computerized Tomography (SPECT) analysis with Iofetamine I123 was performed in patients with various Central Nervous System (CNS) dysfunctions before and after a single exposure to hyperbaric oxygen (1.5 ATA for 60 minutes) as a guide to potential therapeutic intervention. In CNS disorders current measurements had precluded the identification of idling neurons or the ischemic penumbra, as most techniques involved electrophysiological computerized data. Poorly functioning, yet viable cells, if not electrically active are not identifiable. These cells, however, given the proper oxygen/glucose ratio may return to normal function with dramatic results. Increased Iofetamine I-123 tracer uptake in these ischemic areas (idling neurons) after hyperbaric oxygen therapy probably reflects reactivation of hypometabolic neuronal tissue. Unlike MRI or CT, SPECT reflects regional blood flow as well as grey matter metabolism. The similarity to PET imaging is noteworthy. A variety of patients with central nervous system dysfunction were studied. Reactivation of marginal or idling neurons was seen in many disease entities, the most dramatic being long standing hypoxic encephalopathies. Demonstrative cases will be presented including hypoxic encephalopathy and acute and chronic neurologic deficit of stroke. Reactivation of the idling neuron may be of clinical significance. It is important for the physician to differentiate between viable and non-viable tissue, both from the standpoint of treatment and prognosis.

Neubauer, R.A. "Generalized small-vessel stenosis in the brain. A case History of a Patient Treated with Monoplace Hyperbaric Oxygen at 1.5 to 2 ATA." MINERVA MEDICA, l983; 74: 2051-2055.

Complete evaluation of older patients with mental changes always leaves us with a certain percentage whose condition can only be attributed to atherosclerosis. Little is being done for these patients because this generalized stenosis of the brain does not reverse with any known treatment. This writer has treated many such patients with hyperbaric oxygen (HBO), and presents this case history, along with regional cerebral blood flow (rCBF) studies, showing the type of changes which frequently occur. This case initially presented with symptoms of gross mental confusion, memory loss, both recent and remote, irrational speech and occasional violence. Although prior complete evaluations were concluded with no recommended treatment, the initial series of HBO treatment resulted in a well-functioning patient. This was maintained for four years with intermittent HBO. The patient then presented with acute stroke, total disorientation and confusion. He again became functional with HBO. A discussion of the mechanisms of HBO which might account for the changes is given.

Neubauer, R.A. et al. "Hyperbaric Oxygenation as an Adjunct Therapy in Strokes Due to Thrombosis." STROKE, l980; 11(3): 297-300.

Results are reported using hyperbaric oxygenation (HBO) in 122 patients with strokes due to thrombosis, both acute and completed. HBO is used as adjunctive treatment and there appears to be justification for a controlled study to delineate the treatment further. The authors believe it is essential to treat patients with stroke at 1.5 to 2 atmospheres absolute (ATA).

Nighoghossian, N. et al. "Hyperbaric oxygen in the treatment of acute ischemic stroke: an unsettle issue."; JOURNAL OF THE NEUROLOGICAL SCIENCES, 1997; 150(1): 27-31.

Therapy for acute ischemic stroke can be approached in two basic ways: first, by an attempt to restore or improve blood flow in an occluded vascular territory and, second, via therapy directed at the cellular and metabolic targets. As local anoxia and energy failure are the initiating cellular stage in ischemia, the inhalation of oxygen at increased atmospheric pressures might be effective. Treatment of acute focal cerebral ischemia with hyperbaric oxygen (HBO) has been reported in animals and humans. In general, the results of research in animals have suggested a promising role for the use of HBO. More than 400 cases of human ischemic stroke treated with HBO have been reported. In about half of the cases, improvement in status has been claimed on clinical or electroencephalographic grounds. "It might be speculated that the patients most likely to respond favorably to HBO therapy are those who have infarcts related to large vessel thrombosis and surrounded by ischemic penumbra. In support of this are reports claiming a favorable transient or,less often,permanent response to HBO in cases selected for demonstrated carotid occlusion. A large double-blind study might be required in the future. Based on experimental data, HBO at 1.5 ATA during 1 hour might be proposed, as neurotoxicity is rare with low pressure and short duration. If HBO treatment is safe and effective, it could be added to thrombolytic therapy which has recently shown its efficiency in restoring cerebral blood flow."

Nighoghossian, N. et al. "Hyperbaric Oxygen in the Treatment of Acute Ischemic Stroke. A Double-blind Pilot Study." STROKE, l995; 26: 1369-1372.

Background and Purpose: The effects of hyperbaric oxygen (HBO) therapy on humans are uncertain. Our study aims first to outline the practical aspects and the safety of HBO treatment and then to evaluate the effect of HBO on long-term disability.

Methods: Patients who experienced middle cerebral artery occlusion and were seen within 24 hours of onset were randomized to receive either active (HBO) or sham (air) treatment. The HBO patients were exposed daily to

40 minutes at 1.5 atmospheres absolute for a total of 10. We used the Orgogozo scale to establish a pretreatment functional level. Changes in the Orgogozo scale score at 6 months and 1 year after therapy were used to assess the therapeutic efficacy of HBO. In addition, we used the Rankin scale and our own 10-point scale to assess long term-disability at 6 months and 1 year. Two sample t tests and 95% confidence intervals were used to compare the mean differences between the two treatment groups. Student's two-tailed test was used to compare the differences between pre-therapeutic and post-therapeutic scores at 6 months and 1 year in the two treatment groups.

Results: Over the 3 years of study enrollment, 34 patients were randomized, 17 to hyperbaric treatment with air and 17 to hyperbaric treatment with 100% oxygen. There was no significant difference at inclusion between groups regarding age, time from stroke onset to randomization and Orgogozo scale.

Neurological deterioration occurred during the first week in 4 patients in the sham group, 3 of whom died; this worsening was clearly related to the ischemic damage. Treatment was also discontinued for 3 patients in the HBO group who experienced myocardial infarction, a worsening related to the ischemic process, and claustrophobia. Therefore, 27 patients (13 in the sham group and 14 in the HBO group) completed a full course of therapy.

The mean score of the HBO group was significantly better on the Orogozo scale at 1 year. However, the difference at 1 year between pre-therapeutic and post-therapeutic scores was not significantly different in the two groups. Moreover, no statistically significant improvement was observed in the HBO group at 6 months and 1 year according to Rankin score and our own 10-point scale.

Conclusions: Although the small number of patients in each group precludes any conclusion regarding the potential deleterious effect of HBO, we did not observe the major side effects usually related to HBO. Accordingly, it can be assumed that hyperbaric oxygen might be safe. We hypothesize that HBO might improve outcome after stroke, as we detected an outcome trend favoring HBO therapy. A large randomized trial might be required to address the efficacy of this therapy.

Raju, GS, et al."Cerebral accident during endoscopy: Consider cerebral air embolism, a rapidly reversible event with hyperbaric oxygen therapy." GASTROINTEST ENDOSC, 47(1): 70-73, 1998.

A 75 year old male could not swallow solids. During endoscopic dilatation, the patient became hypoxic and unresponsive. He was mute, could not understand speech and could not move his limbs on the left side. A CT scan of the brain showed intravascular air bubbles in the right middle cerebral artery. Within two hours of the event, he was treated with hyperbaric oxygen therapy at 3 ata for 46 minutes and at 2 ata for 150 minutes. A follow up CT scan showed resolution of the air bubbles. That evening he was able to move his left arm again. Several days later, he was able to walk with minimal assistance and his speech and comprehension returned to normal.

Veltkamp, Roland. "Hyperbaric oxygen-A neuroprotective adjunct for hyperacute ischemic stroke?" Letter. J NEUROL SCI, 150, pg.1-2; 1997.

The author writes that though the benefit from HBO therapy is still speculative, its neuroprotective potential may be greater just after stroke onset. He suggests that portable HBO equipment be designed for the initiation of therapy on site by trained personnel before and during emergency transportation to the hospital. He then states that as soon as the equipment is available, "the effectiveness of HBOT in combination with other new hyperacute stroke therapies can and must be (re-)explored."