

Pretreatment with Hyperbaric Oxygen and its effect on neuropsychometric dysfunction and systemic inflammatory response after cardiopulmonary bypass

1: J Thorac Cardiovasc Surg. 2005 Dec;130(6):1623-30. Epub 2005 Oct 26.

Alex J, Laden G, Cale AR, Bennett S, Flowers K, Madden L, Gardiner E, McCollum PT, Griffin SC.

Department of Cardiothoracic Surgery, Castle Hill Hospital, United Kingdom.

OBJECTIVE: Animal studies have shown that pretreatment with Hyperbaric Oxygen can induce central nervous system ischemic tolerance and also modulate the inflammatory response. We evaluated this therapy in patients undergoing cardiopulmonary bypass.

METHODS: Sixty-four patients were prospectively randomized to group A ($n = 31$; atmospheric air, 1.5 atmospheres absolute) or group B ($n = 33$; hyperbaric oxygen, 2.4 atmospheres absolute) before on-pump coronary artery bypass grafting. Age, sex, body mass index, diabetes, hypertension, smoking, coronary disease severity, left ventricular function, Parsonnet score, Euroscore, bypass time, myocardial ischemia time, and number of grafts were comparable in both groups. Canadian Cardiovascular Society angina, New York Heart Association dyspnea, and previous myocardial infarction were significantly higher in group B. Inflammatory markers were analyzed before surgery and 2 and 24 hours after bypass. Neuropsychometric testing was performed 48 hours before surgery and 4 months after surgery and included trail making A and B, the Rey auditory verbal learning test, grooved peg board, information processing table A, and digit span forward and backward. Neuropsychometric dysfunction was defined as more than 1 SD deterioration in more than 2 neuropsychometric tests. Chi-square tests, Fisher tests, t tests, and analysis of variance were used as appropriate for statistical analysis.

RESULTS: Group A had a significant postoperative increase in the inflammatory markers soluble E-selectin, CD18, and heat shock protein 70. This was not observed in group B. Neuropsychometric dysfunction was also significantly higher in group A compared with group B. There was no difference in any other early postoperative clinical outcome.

CONCLUSIONS: Our results seem to indicate that pretreatment with Hyperbaric Oxygen can reduce neuropsychometric dysfunction and also modulate the inflammatory response after cardiopulmonary bypass.

HYPERBARIC OXYGEN IN THE TREATMENT OF THE POSTOPERATIVE LOW-CARDIAC-OUTPUT SYNDROME

M.H. YACOUB M.B. Cairo, F.R.C.S., F.R.C.S.E., F.R.C.S.G. SENIOR SURGICAL REGISTRAR G.L. ZEITLIN M.B. Cantab., F.F.A.R.C.S. SENIOR ANAESTHETIC REGISTRAR LONDON CHEST HOSPITAL, LONDON, E 2

It has been our experience that patients who develop the low-cardiac-output syndrome in association with pulmonary hypertension after cardiac surgery seldom recover despite vigorous treatment. We report here the case of a patient who was successfully treated by means of hyperbaric oxygen therapy. Case-report a 50-yr-old man was admitted to the London Chest Hospital on Oct. 23, 1964. He had a history of productive cough, recurrent haemoptysis, and dyspnoea on exertion for 21 years. He had been discharged from the Army 20 years before with mitral valve disease.

Mr. J.R. Belcher performed the operation on Nov. 3, 1964 after the operation the patient displayed all the signs of a low cardiac output - failure to recover consciousness with no localizing cerebral signs, severe peripheral cyanosis, and a very slow capillary refill in the limbs. Since the patient's condition was now desperate, it was decided to use hyperbaric oxygen therapy. He was placed in the Vickers mobile chamber at a pressure of 2 atmospheres absolute. Since there were no facilities in the chamber for artificial respiration, transfusion or drainage these had to be discontinued.

The patient's condition began to improve after an hour inside the chamber; he was taken out of it every 2 hours to aspirate from his bronchial tree the considerable amount of heavily bloodstained sputum. After 12 hours treatment, he began to move and gradually recovered consciousness for the first time since the operation. Summary and Conclusions In the immediate postoperative period after mitral valvotomy a patient who had shown signs of pulmonary hypertension preoperatively, and a raised pulmonary artery pressure at thoracotomy, displayed all the signs of low cardiac output. In an attempt to lower the pulmonary vascular resistance and raise the cardiac output, he was artificially ventilated with 100% oxygen. This was ineffective, and the patient's death seemed certain. Hyperbaric oxygen treatment was then instituted. Within an hour, his condition began to improve, and, though artificial ventilation, pleural drainage, endotracheal suction, and intravenous therapy were not feasible, he continued to improve while in the chamber. This case suggests that hyperbaric-oxygen therapy helps to support life during the critical period of post-operative low cardiac output in patients with pulmonary hypertension and justifies further trial of the technique in similar cases.

Abstracted from the Lancet March 13th 1965 pages 581-583 (Yacoub is now Prof Sir MH Yacoub). N.B. The patient was treated in an ambulance in the car park of the hospital.

Philip James M.D.
Wolfson Hyperbaric Medicine Unit
The University of Dundee

1999 Cardiac arrest of 30 minutes with defibrillation.

Male aged 46 had a cardiac arrest in the community. Defibrillated by paramedics after about 30 minutes. Admitted to CCU and opened his eyes after three days. He began to say single words on day 5. Transferred to general ward on day 6. Gradually declined over 5 weeks with the development of spastic paraparesis, despite daily physiotherapy. Prescribed. . His leg spasticity became so severe that it was very difficult to bend his legs to allow him to use a wheelchair. His arms were also developing mild stiffness. He had periods in which he spoke 20 words clearly, but they made little sense. He recognized his family.

Hyperbaric oxygen therapy was started after 5 weeks. 54 daily, one hour, hyperbaric oxygen sessions were undertaken at 1.75 atm abs. His cognition and speech improved and there was dramatic improvement in his spasticity. He left hospital walking without assistance.

Comment

This illustrates Ischemia with mid brain edema. Giving high dosage oxygen post arrest would on present evidence- have prevented the associated reperfusion injury and spared some of the cortical damage.

Philip James M.D.
Wolfson Hyperbaric Medicine Unit
University of Dundee

Hyperbaric Oxygen and Your Heart

by Medical Journalist Morton Walker, D.P.M., USA

What's the first treatment an emergency room doctor would administer to you if you were wheeled into the E.R. with angina pain, or a heart attack?

After evaluating my question, if your answer is "An oxygen mask," you are correct.

In angina pectoris, you have a literal suffocation of the heart. It simply isn't getting the oxygen it needs because of an insufficient blood supply that ordinarily carries cellular oxygen molecules. This deficiency can be from blocked arteries heading toward the heart, or from a temporary vasoconstriction of those same arteries as occurs in stress.

In a heart attack, there is an occlusion, also due to blockage or constriction, but such clogging involves the coronary arteries which actually feed the heart muscle. This lack of nourishing blood to the pumping muscle most commonly leads to "myocardial infarction" (development of a dead part within the heart) and could very well result in the victim's death.

Recognition of oxygen's physiological importance is age-old knowledge, but only recently has medical science provided us with guidelines as to how much and when. Simple cause and effect has been the basis of most of our past wisdom. For example, we feel better when we exercise, increasing our oxygen intake. Today, many doctors are utilizing hyperoxia -- forcefully increasing oxygen intake by use of an oxygen (O₂) mask or chamber -- as a part of their overall therapy in reversing or treating heart disease.

There are perhaps only two main reasons why all doctors aren't routinely using pressurized oxygen hyperbaric oxygen therapy (HBOT). First is ignorance as to its efficacy for a wide variety of ailments, and second is the unavailability of hyperbaric medicine chambers for the delivery of oxygen under pressure.

Cardiac Therapy

After being exposed to the pioneering work of hyperbaricist George Hart, MD, at the American Heart Association's (AHA) 65th Scientific Session held in New Orleans on November 16, 1992, the AHA issued a press release praising the use of hyperbaric oxygen to boost emergency treatment for heart attack. It advised medical journalists that hyperbaric oxygen (HBO) as treatment enhances clot-dissolving drugs' ability to minimize heart damage and save the lives of heart attack patients.

The addition of HBOT resulted in earlier relief of chest pain and electrocardiogram (ECG) changes toward normal in patients treated with the clot-dissolver, tissue plasminogen activator (TPA). HBOT also tended to preserve more of the heart's blood-pumping capacity, compared to treatment with TPA alone, said Myrvin H. Ellestad, MD, director of research at the Memorial Heart Institute at Long Beach Memorial Medical Center in Long Beach, California.

Laboratory studies have shown that hyperbaric oxygen minimizes cell damage and death by reducing fluid accumulation in the injured cells. "We believe the same thing happens in patients," said Dr. Ellestad. "In heart attacks, sort of the last straw that kills cells is increasing cell water, which finally breaks the cell membrane. We believe hyperbaric oxygen's primary effect in heart attack may be to reduce edema [fluid accumulation] in heart cells."

The Long Beach group studied forty-six heart attack patients, twenty-two of whom received only TPA. The remaining twenty-four patients got TPA, followed by two hours of treatment in a hyperbaric chamber. It provided a pure oxygen environment with twice the normal atmospheric pressure (two atmospheres absolute).

Patients treated with HBOT felt chest pain relief an average of 271 minutes after the onset of heart attack symptoms, a statistically significant difference compared to the 671 minutes for patients who received only TPA. Dr. Ellestad said patients generally reported an easing of chest pain within ten minutes of entering the hyperbaric chamber.

HBO therapy reduced by 50 percent the time required for the heart to resume normal electrical activity, as determined by an electrocardiogram (ECG) finding called "ST normalization." ("S" and "T" waves are two points on an ECG tracing.) The time was 188 minutes for patients who went into the chamber vs 374 for those who did not.

"We've clearly shown that pain goes away very quickly and ST elevation, which we think is a sign of the heart muscle dying, returns to normal more rapidly," said Dr. Ellestad. "To me, the most dramatic aspect of the study was watching as ST elevation returned to normal after a patient went into the chamber. That tells me we're salvaging heart muscle cells."

There's some evidence that HBOT decreases activity by oxygen free radicals. These are unstable molecules known to damage or destroy cells.

Two other findings provided additional evidence of benefits from HBO therapy. Patients sent to the chamber had significantly lower blood levels of the enzyme creatine phosphokinase, which is released during a heart attack and indicates the extent of heart muscle damage. Patients treated in the hyperbaric chamber also had a higher ejection fraction, a measurement that reflects how well the heart can pump blood.

Dr. Ellestad sees potential for even better results with HBOT if patients can begin oxygen therapy sooner. Transporting patients to the chamber and preparing them for treatment require about thirty minutes. He and his colleagues hope to reduce that time at Long Beach Memorial by relocating the hyperbaric chamber to the hospital's emergency room.

Physician interest in HBO treatment for heart attack patients goes back a number of years; however, the interest had dwindled after the emergence of TPA and other clot-dissolving agents. Then, an unusual event prompted Dr. Ellestad and his colleagues to take another look at HBOT.

George Hart, MD, director of the hyperbaric unit at the hospital and an investigator in the study reported at the AHA 1992 New Orleans meeting, began having chest pains and decided to treat himself in the oxygen chamber. The HBOT relieved his heart pain in minutes. Being friends, Dr. Ellestad checked out what Dr. Hart explained about his HBOT experience.

Hyperbaric chambers are not standard equipment at hospitals and medical centers. If HBOT proved beneficial for a hospital, most likely it could afford the \$80,000 to \$90,000 cost for a single-patient chamber. This is the type used in the test at Long Beach Memorial Hospital. HBOT adds about \$200 to the daily cost of treating a heart attack patient, Dr. Ellestad said.

Besides Drs. Ellestad and Hart, investigators in the study included Adrian H. Shandling, MD, John C. Messenger, MD, Bruce VanNatta, MD, Daniel D. Whitcraft, MD, Roger H. Rizi, MD, Ronald H. Selvester, MD, Michael Hayes, MD, and Clyde W. Smith, MD.

More Studies Show the Efficacy of HBO for Heart Disease

The Long Beach Memorial Hospital's investigation is just one among thousands proving the efficacy of HBO for heart disease. Medical professionals and hyperbaric scientists around the world have proven the benefits of applying HBO for the reduction of actual reversal of most heart disease signs and symptoms. Their presentations are highly significant for furthering heart health.

The renowned Russian hyperbaricist Serge I. Rodionov, MD, who practices HBOT in Moscow, told how pharmaceutical agents prescribed for the treatment of cerebrovascular disease, cardiomyopathy, and heart failure are potentiated by hyperbarics. Drug effects increased when the heart patient was placed in a pressure chamber for just one hour per week.

By the date of his 1989 lecture, Dr. Rodionov affirmed there were over 3,000 HBO chambers strategically located around the country, which was then the original Union of Soviet Socialist Republics. And, he said, acceptance of the modality was gaining in the medical community for the treatment of heart disease. Today, just in the newly formed smaller nation of Russia itself, 3,000 chambers have been installed and are functioning.

Thirteen Benefits the Heart Receives from Oxygen Under Pressure

The nature of heart disease is such that insufficient oxygen is getting to the heart. This results in the various discomforts which affect a patient: difficulty breathing, inability to exert oneself, pressure in the chest, and other problems.

Breathing normal air results in a mere 0.3 ml of oxygen dissolving into each 100 ml of blood. Any other oxygen is bound by the hemoglobin attached to red blood cells, and it essentially becomes unavailable. The need in heart disease is to get more oxygen molecules into the body and brain.

From the published scientific papers on HBO, Dr. Steenblock offers thirteen true benefits that the heart receives from exposure to oxygen under pressure. Clinical investigations by prime users of HBO from around the world, especially from Russian exponents, have shown the following heart advantages:

1. Hyperbaric oxygen therapy applied to the heart during critical loss of oxygen exerts a remarkable defibrillating effect so that tremulous, rapid, ineffectual contractions are prevented; total death of the heart muscle cells is avoided; and abnormal dilation of the blood vessels with subsequent complications is controlled.
2. Using HBOT in conjunction with various drugs enhances the effectiveness of both the oxygen and the drugs.
3. Combining HBOT with drugs completely arrests or considerably reduces angina attacks in patients otherwise resistant to prolonged drug treatment.
4. Patients with cardiac pain from ischemic heart disease experience total relief, along with disappearance of dyspnea (difficulty breathing), when they receive HBOT.
5. Administering HBOT lowered elevated blood cholesterol in all 220 patients cited in a study conducted by the Russian internist Dr. S.A. Borukhov and her colleagues.
6. HBOT normalized electrocardiograms in all patients in that same Soviet study.
7. For diminished muscular power of the heart, HBO exerts long-term normalizing effects for circulating blood through the body.
8. HBOT exerts antiarrhythmic action on the heart.
9. HBOT increases heart patients' tolerance to hard work and taking on physical loads
10. HBO taken at three atmospheres of pressure (a pressure rarely used in the United States) protects any individual's heart from damages due to lack of oxygen.
11. One's entire heart conduction system functions better from receiving HBO treatment (even when prophylactically administered).
12. Without taking drugs of any kind, breathing oxygen under pressure stabilizes impaired fat metabolism and improves liver function for someone with ischemic heart disease.
13. Due to its characteristic of mollifying stress and distress, HBO has long-term and short-term protective effects for a person with a heart problem.

How HBOT Further Enhances the Ailing Heart

As a result of elevating the atmospheric pressure inside the hyperbaric chamber by 1-1/2 to 2 atmospheres absolute (ATA), plus administering 100 percent oxygen to the cardiac patient by means of a face mask, this ill person receives a sharply increased amount of oxygen dissolved in the plasma. Such improved blood oxygen content tends to give the damaged heart an assist in oxygenating body tissues which provides time for the myocardium to recover and develop

extra circulation around the area of the infarct, a localized area of decay in the heart muscle resulting from the interruption in blood supply.

As shown in the studies cited above, hyperbaric oxygen therapy for the relief of myocardial infarction has tremendous value for recovery of the patient. It increases oxygen intake for building collateral circulation in cases of angina pectoris, as well. HBO should not be reserved only for patients in cardiac intensive care units.

Family practice physicians sometimes stop themselves from requesting HBO therapy for their cardiac patients because they suspect there's a vasoconstrictive effect of HBO. Erroneously the doctors may conclude that such treatment is dangerous and shouldn't be utilized on already constricted blood vessels. That's not true! Medical studies well-performed according to the scientific method show that hyperoxic vasoconstriction occurs in healthy tissue only. On the damaged ischemic tissue, vasodilation that occurs naturally counteracts any vasoconstriction produced by HBO. Higher amounts of blood flowing to areas of hypoxia create the opening of collateral blood vessels.

Hyperbaric oxygen therapy is an assist to the body's own healing mechanism. By itself, HBO would probably not offer the desired results. Numerous studies on animals conducted in the 1960's, in fact, showed unfavorable results using the treatment for heart disease. A closer look at the studies, however, reveals that they were performed on anesthetized dogs, laying helplessly on a table with various tubes running in and out of them. These animals were given drugs to induce some type of heart malfunction, then hyperbaric oxygen was administered, usually at far too high a pressure, for either too long or too short a time.

Such procedures on animals don't translate neatly into the human condition. The human patient can alter his or her risk factors by improving diet, stopping smoking, increasing exercise, and doing those various other beneficial things that I've mentioned. Definitely, chelation therapy taken along with the HBO received at the proper pressure, for the time needed to effect heart disease reversal, is the ideal way to go. Retaining risk factors is ridiculous, but that was done in experiments with the anesthetized dogs. Such experiments were fated for failure and did fail. Still, the studies were reported in the clinical journals and threw off physician/readers from following the correct path as regarding the use of hyperbaric oxygen as therapy for angina, myocardial infarction, and other heart ailments.

As we have stated, very little oxygen is dissolved in blood plasma at the normal atmospheric pressure of 102 millimeters of mercury (mm Hg). HBO therapy forcefully puts oxygen unbound by hemoglobin into the blood plasma. This increases the blood oxygen level fourteen times to 1433 mm Hg and thereby delivers much greater quantities of oxygen to oxygen-starved tissues. Those organs, tissues, and cells that have been suffering from a lack of oxygen because of poor circulation or damage then will become revitalized and begin to function more effectively.

The London Westminster Hospital Experience with HBOT

In London, C.J. Gavey, MD, chief of the cardiac department at Westminster Hospital, pressurized heart-attack patients to save their lives. For four days, He subjected them to 2 ATA in 100 percent oxygen for two hours, followed by a rest of one hour in plain air, and then continued the cycle of two hours in the chamber and one hour out. His idea was to send oxygen through the unblocked blood vessels to the ischemic tissues at the edge of the infarct area, preventing the impending death of additional heart muscle. He figured that this procedure might avoid the triggering of fatal arrhythmias.

Forty men and women who had suffered serious heart attacks within twenty-four hours were treated this way by Dr. Gavey. They ranged in age from thirty-five to seventy-two years. Surviving their cardiovascular accidents as a result of undergoing the HBO procedure directly upon their admittance to London's Westminster Hospital were 92.5 percent of the acutely affected patients. Of these thirty-seven initial survivors, three died within fifteen days, giving a final survival rate of 85 percent.

Quite significant was the reduction of heart pain experienced by these patients. Almost a quarter-century before Dr. Myrv in Ellestad made his AHA conference presentation, Dr. Gavey reports that twenty-three of his patients arrived in severe pain and fourteen had difficulty breathing. Once settled into the pressure chamber, none of the patients felt any more pain. Within thirty minutes of pressurization, their breathing problems eased too.

Inasmuch as only the really critical cases (those who potentially could die on the spot) have been administered HBO, such results were quite heartening to the Westminster Hospital authorities. They considered that HBO therapy saved some patients from fatal cardiogenic shock. The optimum hyperbaric regimen for cardiac conditions, however, was not defined and was still being decided upon twenty-five years after Dr. Gavey's clinical experiment. Dr. Ellestad confirmed Dr. Gavey's report.

How Strange It Is That Cardiologists Don't Prescribe HBOT

If heart disease allows insufficient oxygen to get into the heart muscle as stated earlier, various symptoms that most of us can identify must result. With O₂ being inhaled at normal atmospheric pressure but not preventing cardiovascular problems for the more than 1,200,000 heart attack victims each year in the United States alone, obviously greater amounts of this life-giving element must be obtained. HBO administered at the established two atmospheres absolute to force O₂ into the body, allows the doctor to effect 4.3 ml of oxygen being dissolved into each 100 ml of blood. Thus a cardiologist or other doctor is furnishing therapeutic oxygen amounting to a fourteenfold increase! Simply, this is Henry's gas law of physics at work.

Using modern equipment in this way, any skilled physician can safely elevate available oxygen for his patient to provide pain relief, to prevent fatal arrhythmias or shock, and to allow time for collateral blood circulation to develop. Yet, HBO seldom is used in the U.S. to reverse heart disease before it becomes near fatal. Isn't it strange that cardiologists don't routinely utilize hyperbaric oxygen as a valid therapy? Even odder is that they almost never employ the modality to benefit their cardiac patients at all. That's because the average American allopathic physician, traditionally trained primarily in the use of drugs and surgery, usually fails to have access to and certainly does not personally own a hyperbaric chamber. Moreover, the doctor probably is unfamiliar with what taking oxygen under pressure can do for promoting human homeostasis.

We have a most peculiar conundrum here, for which the answer would be funny if we were not dealing with matters of life and death. Note the irony: Of the hundreds of published scientific studies applied to heart disease, the set of elements you will seldom read or hear about is the mention of diet, exercise, smoking, and drinking habits of the cardiac patient in conjunction with administering HBOT to him or her. This is a commonsense procedure: the use of hyperbaric oxygen with one's everyday healthy lifestyle.

Instead, detailed instructions usually are given only for the various drugs being tested with HBO. Combining hyperbaric oxygen with those other more vital factors involving lifestyle, poor lifestyle practices probably being the source of heart weakness or disease in the first place, could optimize the outcome for an involved cardiac patient.

Reprinted with Permission

Research References

1. Dmitrieva, E.M., et al. "Hyperbaric oxygenation in experimental therapy of acute regional hypoxia of the myocardium and brain." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 276-277.
2. Glants, B.R. "Therapeutic effects of mercazol in combination with hyperbaric oxygenation in the treatment of acute myocardial hypoxia." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, p. 275.

3. Kogan, A.H., et al. "The question of the use of antioxidants, beta-adrenergic blockers, and cardiac glycosides in oxygen therapy of acute myocardial infarction." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 275-276.
4. Yefuni, S.N., et al. "The use of hyperbaric oxygenation in combined therapy of acute myocardial infarction." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 264-265.
5. Zamotaev, I.P. et al. "Hyperbaric oxygenation in the treatment of ischemic heart disease and peptic ulcer of stomach and duodenum." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, p. 269.
6. Op. Cit. Yefuni, S.N.
7. Kolomeitseva, S.P., et al. "Hyperbaric oxygenation as an adjunct in the treatment of ischemic heart disease." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, p. 266.
8. Kuleschova, M.R., et al. "Physical rehabilitation of patients with ischemic heart disease using hyperbaric oxygenation." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 268-269.
9. Golyakov, V.N., et al. "Hemostasis in patients with ischemic heart disease during hyperbaric oxygenation." *Klin. Med. (Mosk)* 64(2): 92-95, 1986.
10. Borukhov, S.A., et al. "HBO effect on clinico-biochemical blood indexes in patients with ischemic heart disease." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 271-272.
11. Ashfield, R., et al. "Severe acute myocardial infarction treated with hyperbaric oxygen. Report on forty patients." *Postgrad. Med. J.* 45:648-654, October 1969.
12. Op. Cit. Borukhov, S.A.
13. Ibid.
14. Isakov, Y.V., et al. "Hyperbaric oxygenation in combined treatment of paroxysmal tachyarrhythmias, in ischemic heart disease." *Kardiologiiia* 21(4):42-45, April 1981.
15. Ivleva, V.I., et al. "Effect of hyperbaric oxygenation on the activity of the sympathoadrenal and Kallikrein-Kinin systems of blood in some disorders of cardiac rhythm." *Ter Arkh* 53(5):66-68, 1981.
16. Malinovsky, N.N., et al. "The use of hyperbaric oxygenation in cardiac arrhythmia." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 284-285.
17. Timchuk, I.D., et al. "Hyperbaric oxygenation in complex treatment of patients with disorders of rhythm and conduction of heart." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, p. 286.
18. Op. Cit. Kolomeitseva, S.P.
19. Kulkybaev, G.A., et al. "Functional state of the cardiovascular system and lungs of patients with chronic ischemic heart disease under conditions of hyperbaric oxygenation." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 269-270.
20. Kostyukov, V.V., et al. "Coronary circulation and oxygen regime of the myocardium at a low cardiac output and HBO." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, p. 276.
21. Rugenyus, Y.Y., et al. "The effect of hyperbaric oxygenation on the conductive system of the heart in patients with ischemic heart disease." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, p. 271.
22. Zhumanov, K.D., et al. "A study on metabolic indexes in patients with chronic ischemic heart disease subjected to hyperbaric oxygenation." In: Abstracts VII Int. Cong. HBO Medicine, Moscow, Sept. 2-6, 1981, pp. 270-271.
23. Op. Cit. Ashfield, R.
24. "Hyperbaric unit puts pressure on heart deaths." *Medical World News*, May 24, 1968.
25. Tufano, R., et al. "Hyperbaric oxygen effects on pain relief in patients with vascular disease." *J. Hyperbaric Medicine*, Vol. 3, No. 1, 1988.
26. Visona, A., et al. "Hyperbaric oxygenation in the treatment of peripheral vascular disease." *J. Hyperbaric Medicine*, Vol. 2, No. 4, 1987.
27. Trimble, V.H. *The Uncertain Miracle: Hyperbaric Oxygenation*. (Garden City, NY: Doubleday, 1974), pp. 124 - 127.

Autonomic Nervous System in the Patients with Coronary Artery Diseases during Hyperbaric Oxygenation Therapy.

Stepanov Andrey, MD; Stepanova Svetlana, MD.

Central Clinical Hospital N5

Department of Blood Purification and Hyperbaric Oxygenation Therapy

Cardiology Department

Kharkov, Ukraine.

Abstract

Introductions: Hyperbaric oxygenation therapy (HBOT) is inhalation of pure oxygen at greater than 1 atm absolute pressure. Prior trials detected benefits from HBOT for patients with coronary artery diseases (CAD). But not all is known about the influence of HBOT on autonomic nervous system (ANS). Heart rate variability (HRV) is a proven tool for examining the ANS.

Objectives: The aim of this study was to assess the changes in ANS during HBOT by using the HRV.

Material and Method: The first group of 6 patients with CAD were pressurized up to 1,5 atm absolute pressure (aap) and remained at this pressure for 40 minutes. In the control group these 6 patients stayed in HBOT chamber under 1,0 aap in 21-40% oxygen instead sessions 1 and 7. The HRV was recorded using "Cardiolab 2000" system during sessions 2, 6 and 10. Patients were examined before HBOT and on the first and 40th minute under 1,5 aap. TP, LF, HF, and LF/HF ratio were analysed for the frequency domain measures.

Results: In the first group we observed significant increase ($p<0,05$) of TP by 97%, LF by 56%, HF by 97%, LF/HF ratio decreased by 1,76 ($p<0,05$). There were no significant changes in the control group.

Discussion: The analysis of indexes of HRV during a HBOT session showed significant increase of parasympathetic activity and total variability in the first group compared with control group.

Conclusion: HRV might be helpful in monitoring during session of HBOT and it can reflect the effect for patients with CAD. HBOT can improve prognosis in patients with CAD.

Introduction: Hyperbaric oxygenation therapy (HBOT) is inhalation of pure oxygen at greater than 1 atm absolute pressure. Prior trials detected benefits from HBOT for patients with coronary artery diseases (CAD) [5] and acute myocardial infarction [4]. HBOT increases plasma concentration of dissolved oxygen, and this effect may normalize or even increase oxygen tension to hyperoxic levels in ischemic tissue [2]. HBOT is a useful modality for treatment of diseases in which tissue oxygen availability is decreased. HBOT reduces the ischemic effects of coronary artery occlusion in animal and clinical studies [3]. But a little is known about the influence of HBOT on autonomic nervous system (ANS). The changes in ANS have a high relation with cardiac function and mortality [9, 10, 11, 13]. The heart rate variability (HRV) as the one of potential prognostic value of markers of autonomic activity has gained progressive popularity [6,7]. Now HRV is a proven tool for examining the ANS [12].

Objectives: The aim of this study was to assess the changes in ANS in patients with CAD during HBOT by using the technique of HRV.

Material and Methods: The study's patients received HBOT as adjunctive therapy of CAD and they were drawn from the Cardiology Department of Central Clinical Hospital N5, Kharkov. They were 4 men and two women, mean age 52 ± 10 year. All of the patients were in sinus rhythm; none had history of acute myocardial infarction. The study began in

September 1998 and it is still in progress. This is a preliminary report. The first group included 6 patients with CAD (stable angina pectoris I–III class NYHA) and receiving usual treatment.

Patient were pressurized during 15-20 minute period up to 1,5 atmosphere absolute pressure (aap) and remained at this pressure for 40 minutes and then depressurized during 15 minute period to normal atmosphere pressure. Total time of HBOT was 70 - 80 minutes. In the control group these 6 patients stayed in HBOT chamber under 1,0 aap in the 21- 40% oxygen's atmosphere instead first, 7th and 11th HBOT sessions during 70 - 80 minutes. We used monoplace chamber "OKA-MT" with 1m³ volume inside. Monitoring of electrocardiogram (ECG), noninvasive blood pressure (before and after HBOT in supine position) was performed during HBOT sessions. Every patient received 10 HBOT sessions in the same time every day.

HRV was calculated in general agreement with the standards of measurement proposed by Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology [1]. The HRV was recorded using computer based electrocardiograph system "Cardiolab 2000" during sessions 2, 6 and 10 before HBOT, on the first minute under the 1,5 aap and on 40th minute under 1,5 aap. In the control group the HRV was recorded before HBOT, on 15 and 55 minutes of the sessions 1, 7 and 11.

HRV was analyzed on 5-minute period of stable ECG recording for the frequency domain measures with the use of fast Fourier transform. We measured the total power (TP) of the R – R interval (0 – 0.5 Hz). The frequency ranges were subdivided into 0.03 – 0.15 Hz as a low frequency component (LF) and 0.15 – 0.5 Hz as a high frequency (HF) one. TP, LF, HF was expressed in absolute values (ms²). We measured also the LF/HF ratio and LF and HF in normalized units (LFn, HFn respectively calculated as a percentage of TP of the R – R interval, from which the power of any component with a frequency of less than 0.03 Hz was removed) [1]. The results are given as mean ± standard deviation (SD). A p-value <0.05 was considered significant.

Results: Table 1 (not Shown) shows the mean values and SD of HRV measurement for the study group before and during HBOT. There were no significant changes in the control group. On the first minute under 1,5 aap we observed significant increase of TP by 99,3% (p=0.006), LF by 138% (p=0.022), HF by 67.6% (p=0.01). Increase of LFn by 0.8% (p=0.26) and decrease of HFn by 1.4% (p=0.32) and LF/HF ratio by 34,8% (p=0,176) was not significant. The changes on the 40th minute under 1,5 aap were significant in all values compared with values before HBOT. We observed significant increase of TP by 153,3% (p=0.001), LF by 155% (p=0.03), HF by 252% (p=0.003), HFn by 39.6% (p=0.003), and decrease of LFn by 25.9% (p=0.004) and LF/HF ratio by 61.1% (p=0,004).

Discussion: As confirmed by other investigator, we found HRV to be reduced in patient with CAD and with the signs of increased sympathetic activity [8]. It has been hypothesized that influences can make impairment of HRV may predict acute myocardial infarction and sudden cardiac death. This is the first study to record changes in frequency domain measures of HRV during HBOT. The analysis of HRV during a HBOT session showed significant changes. We observed significant increase of TP and its components – LF and HF. But if analyze LF/HF as marker of sympathovagal balance and LFn and HFn we could noted the increasing of parasympathetic activity more significant than decreasing of sympathetic activity. From this point of view the use of HBOT for patient with CAD is useful modality as adjunctive increasing of parasympathetic activity. The studies of influence of HBOT on organism is not finished and well understanding the changes in ANS will help in management the patient that received HBOT for a long time (it was reported about more than 200 sessions for one patient). In some patients that were not included in this study we observed decreasing the TP and increasing the LF/HF ratio and it was close correlated with problems during the sessions such as claustrophobia, the signs of hypersensitive to oxygen etc. The positive HRV changes were more expressed at patients with more successful results in treatment. In Figure 1 and Figure 2 (Not Shown) we presented the changes in HRV before and during HBOT.

Conclusions:

Our preliminary results showed that measurement of HRV was helpful in monitoring during the sessions of HBOT and reflected the effects in the treatment of patients with CAD. Adjunctive HBOT can improve prognosis in patients with CAD. Based on values of HRV it will be possible in the future to modulate the protocols of HBOT. Of course it need to explore the influence of other treatment protocols of HBOT on ANS and in particularly how long changes we detected last. In Figure 1 and 2 showed changes in Very LF component that reflected another ways to change HRV, but it will be another report.

The authors wish to thanks the Callahan's and Ockunzi's family, Cleveland, Ohio, USA for assistance.

References

1. Task Force of the European Sosity of Cardiology and the North American Sosity of Pacing and Electrophysiology. Heart Rate Variability. Standards of Measurements, physiological interpretation, and clinical use. Circulation. - 1996. -V. 93.1043-1065.
2. Ackerman NB, Brinkly FB. Oxygen tension in normal and ischemic tissues during hyperbaric treatment. JAMA 1966;198:1280-3
3. Kawamura M, Sakakibara K, Sakakibara B, et al. Protective effect of hyperbaric oxygen for temporary ischemic myocardium: macroscopic and histologic data. Cardiovasc Res 1976; 10:599-604.
4. Adrian H. Shandling, MD, Myrvin H. Ellestad, MD, et al. Hyperbaric oxygen and thrombolysis in myocardial infarction: The "HOT MI" Pilot Study. Am Heart J 134(3): 544-550, 1997.
5. Seriakov VV. Feofanova ID. Hyperbaric oxygenation and antiaggregants: effects on platelet function in patients with ischemic heart disease. Anesteziologiia i Reanimatologiia. (2):31-3, 1997 Mar-Apr.
6. Maria Vittoria Pitzalis, Filippo Mastropasqua, et al. Assesment of cardiac vagal activity in patient with hyperthyroidism. International Journal of Cardiology 64 (1998) 145-151.
7. Simonetta Scavini, Maurizio Volterrani, Emanuela Zanelli et al. International Journal of Cardiology 67 (1998) 9-17.
8. Andrew J. Burger, MD, and Masoor Kamalesh, MD. Effect of Beta-Adrenergic Blocker Therapy on the Circadian Rhythm of Heart Rate Variability in Patients with Chronic Stable Angina Pectoris. The American Journal of Cardiology vol. 83 February 15, 1999.
9. Amara, C.E. and Wolfe, L.A. Reliability of Noninvasive Methods to Measure Cardiac Autonomic Function. Can. J. Appl. Physiol. 23(4):396-408.1998.
10. P. J. Schwartz. The autonomic nervous system and sudden death. European Heart Journal (1998) 19, (Supplement F), F72-F80.
11. Nolan, James MD; Batin, Phillip D. MD; Andrews, Richard MRCP et al. Prospective Study of Heart Rate Variability and Mortality in Chronic Heart Failure: Results of the United Kingdom Heart Failure Evaluation and Assesment of Risk Trial (UK-Heart). Circulation, Vol. 98(15). October 13, 1998. 1510-1516.
12. Singh, Jagmeet P. MD, Dphil; Larson, Martin G. ScD; O'Donnell, Christopher J. MD, MPH et al. Circulation, Vol. 99(17). May 4, 1999.2251-2254.
13. Ad. Van Boven, MD, J. Wouter Jukema, MD, Jaap Haaksma, BSc. Depressed heart rate variability is associated with events in patients with stable coronary artery disease and preserved left ventricular function. American heart Journal Vol. 135, Number 4, 571-575.

Hyperbaric oxygen limits infarct size in ischemic rabbit myocardium in vivo.

Sterling DL, Thornton JD, Swafford A, Gottlieb SF, Bishop SP, Stanley AW, Downey JM.

Department of Biological Sciences, University of South Alabama, Mobile 36688.

BACKGROUND

We explored the ability of increased oxygen pressure to modify necrosis in an open-chest rabbit model of myocardial ischemia and reperfusion.

METHODS AND RESULTS

A branch of the left coronary artery was occluded for 30 minutes followed by 3 hours of reperfusion. Infarction was measured by triphenyl tetrazolium staining and expressed as a percentage of the ischemic zone. Untreated rabbits were ventilated with 100% oxygen at 1 atm absolute. Treatment animals were exposed to hyperbaric oxygen at 2.5 atm absolute. The 1.0-atm control hearts developed 41.5 +/- 4.6% infarction of the ischemic zone. Animals exposed to hyperbaric oxygen during ischemia only, reperfusion only, or ischemia and reperfusion had significantly smaller infarcts with respect to control animals (16.2 +/- 2.9%, 14.5 +/- 3.7%, and 9.8 +/- 2.7%, respectively; P < or = .01), indicating that they had been protected by the procedure. When hyperbaric oxygen was begun 30 minutes after the onset of reperfusion, no protection was seen (35.8 +/- 3.8%).

CONCLUSIONS

We conclude that hyperbaric oxygen limits infarct size in the reperfused rabbit heart and that the effect can be achieved when hyperbaric oxygen is begun at reperfusion.

Atorvastatin decreases the coenzyme Q10 level in the blood of patients at risk for cardiovascular disease and stroke.

Arch Neurol. 2004 Jun;61(6):889-92.

Rundek T, Naini A, Sacco R, Coates K, DiMauro S.

Department of Neurology, Columbia University College of Physicians & Surgeons, New York, NY 10032, USA.

BACKGROUND:

Statins (3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors) are widely used for the treatment of hypercholesterolemia and coronary heart disease and for the prevention of stroke. There have been various adverse effects, most commonly affecting muscle and ranging from myalgia to rhabdomyolysis. These adverse effects may be due to a coenzyme Q(10) (CoQ(10)) deficiency because inhibition of cholesterol biosynthesis also inhibits the synthesis of CoQ(10). OBJECTIVE: To measure CoQ(10) levels in blood from hypercholesterolemic subjects before and after exposure to atorvastatin calcium, 80 mg/d, for 14 and 30 days. DESIGN: Prospective blinded study of the effects of short-term exposure to atorvastatin on blood levels of CoQ(10). SETTING: Stroke center at an academic tertiary care hospital. Patients We examined a cohort of 34 subjects eligible for statin treatment according to National Cholesterol Education Program: Adult Treatment Panel III criteria. RESULTS: The mean +/- SD blood concentration of CoQ(10) was 1.26 +/- 0.47 micro g/mL at baseline, and decreased to 0.62 +/- 0.39 micro g/mL after 30 days of atorvastatin therapy (P<.001). A significant decrease was already detectable after 14 days of treatment (P<.001).

CONCLUSIONS:

Even brief exposure to atorvastatin causes a marked decrease in blood CoQ(10) concentration. Widespread inhibition of CoQ(10) synthesis could explain the most commonly reported adverse effects of statins, especially exercise intolerance, myalgia, and myoglobinuria.

Adjunctive effect of hyperbaric oxygen treatment after thrombolysis on left ventricular function in patients with acute myocardial infarction

October 2004 • Volume 148 • Number 4

Milica Dekleva, MD, PhD Aleksandar Neskovic, MD, PhD, FESC

Alja Vlahovic, MD

Biljana Putnikovic, MD, PhD

Branko Beleslin, MD, FESC

Miodrag Ostojic, MD, PhD, FESC, FACC

Cardiac Abstract:

Background The role of hyperbaric oxygen in patients with acute myocardial infarction is controversial, ranging from not beneficial to having a favorable effect. This randomized study was conducted to further assess the benefit of hyperbaric oxygen treatment after thrombolysis on left ventricular function and remodeling in patients with acute myocardial infarction.

Methods Seventy-four consecutive patients with first acute myocardial infarction were randomly assigned to treatment with hyperbaric oxygen treatment combined with streptokinase (HBO+) or streptokinase alone (HBO-).

Results There was a significant decrease of end-systolic volume index from the first day to the third week in HBO+ patients compared with HBO- patients (from 30.40 to 28.18 vs from 30.89 to 36.68 mL/m², P < .05) accompanied with no changes of end-diastolic volume index in HBO+ compared with increased values in HBO- (from 55.68 to 55.10 vs from 55.87 to 63.82 mL/m², P < .05). Ejection fraction significantly improved in the HBO+ group and decreased in the HBO- group of patients after 3 weeks of acute myocardial infarction (from 46.27% to 50.81% vs from 45.54% to 44.05 %, P < .05).

Conclusions Adjunctive hyperbaric oxygen therapy after thrombolysis in acute myocardial infarction has a favorable effect on left ventricular systolic function and the remodeling process.

Researchers Find More Than 10% of Heart Failure Patients Have Mental Disorder Comorbidities: Presented at HFSA

"Researchers Find More Than 10% of Heart Failure Patients Have Mental Disorder Comorbidities: Presented at HFSA"

By Ed Susman BOCA RATON, FL -- September 23, 2005 -- More than 10% of heart failure patients also have mental disorder comorbidities, reported researchers here at the 9[th annual scientific meeting of the Heart Failure Society of America (HFSA).

"There is growing recognition of the high prevalence of depression and impaired cognition in persons with heart failure, but little attention has been given to other comorbid mental disorders," said Steven Sayers, PhD, Assistant Professor of Psychiatry, University of Pennsylvania, Philadelphia, Pennsylvania, United States. "Mental disorders may interfere with self-care in heart failure patients and contribute to poor outcomes."

To determine the rate of comorbid mental disorders among Medicare patients who were hospitalized for HF, Dr. Sayers and colleagues examined a 5% sample of Medicare records. He presented the results of that examination on September 20th.

Of 13,169 patients with HF identified in that sample, the database indicated that about 1556 (11.8%) patients had comorbid mental disorders.

Depression accounted for 52.8% of patients with mental disorders; 22% had anxiety disorders and 16.7% had psychoses. Alcohol abuse was identified in 16.3% of patients with heart failure and comorbid mental disorders.

"Comorbid depression and psychoses appear to be associated with longer hospitalizations -- almost 3 days [more]," he said. All patients with comorbid mental disorders tended to have more annual hospitalizations than patients with heart failure who did not have mental disorders.

He said that his analysis shows that while patients with comorbid mental disorders tend to use more resources, except for patients with psychoses, there are no increased mortality risks. Patients with alcohol abuse disorder did not increase costs associated with their hospitalizations, he said.

"It is likely that the actual rates of psychiatric comorbidity in this sample are higher than the rates we estimated from administrative data due to common problems of underdetection and underdocumentation of mental disorders," Dr. Sayers noted.

He suggested that this type of comorbidity "may represent an important addressable source of increased costs of healthcare for patients with heart failure."

[Presentation title: Comorbid Mental Disorder among Patients Hospitalized with Heart Failure. Abstract 283]

German Study Links Infection, Heart Disease

By Maggie Fox, Health and Science Correspondent

WASHINGTON (Reuters) - Researchers in Germany said on Monday they had found more evidence that infections with bacteria that cause pneumonia, ear infections and other diseases may also cause heart disease.

The study, in the American Heart Association journal Circulation, adds to a growing body of evidence that the body's response to some infections may help cause heart disease.

"We showed a significant association between the number of infections to which a patient has been exposed and the extent of atherosclerosis in the arteries in the heart, neck and legs," Dr. Hans Rupprecht and Dr. Christine Espinola-Klein of Johannes Gutenberg University in Mainz, Germany, who conducted the study, said in a statement.

"The risk for death was increased by the number of infectious agents, especially in people with advanced artery disease."

Researchers believe it is the body's inflammatory response to an infection that helps, along with a fatty diet, to clog arteries. The plaques that form these clogs are created when immune system cells latch onto fat cells in the blood and try to pull them out through the cell wall.

The fat cell is often too big and it gets caught. The trapped immune and fat cells build up in the artery wall, harden and can block blood flow or break off into clots.

Inflammatory responses to infection can send more of these immune cells circulating, looking for something to do.

Rupprecht's team tested 572 patients with heart disease, most of whom had chest pain or heart attack.

EIGHT MICROBES ASSOCIATED WITH HEART DEATH

They looked herpes simplex virus 1 and 2, which cause cold sores and genital herpes; cytomegalovirus, which is another herpes virus; Epstein-Barr virus, which causes mononucleosis; *Hemophilus influenzae*, a bacteria that causes ear and upper respiratory infections; *Chlamydia pneumoniae*, which can cause pneumonia; *Mycoplasma pneumoniae*, another cause of pneumonia; and *Helicobacter pylori*, which causes most stomach ulcers.

Over the next three years, Rupprecht's team wrote, they found a clear correlation between how many infections a person had and his or her risk of dying from heart disease.

"The antibody titers (levels) for *C. pneumoniae*, *H. pylori*, *H. influenzae*, cytomegalovirus, and herpes simplex virus type 2 were related to the extent of atherosclerosis," Espinola-Klein said in an interview conducted by e-mail.

In patients who tested positive for up to three infections, the death rate was 3.1 percent. The death rate was 9.8 percent for those infected with four to five agents and 15 percent for those with six to eight pathogens.

Twenty percent of the patients with advanced atherosclerosis who had six to eight infections died, compared to 7 percent of those with three exposures or fewer.

"Based on these results, we think that the number of infections to which an individual has been exposed may be involved in the development and progress of atherosclerosis. Both bacterial and viral pathogens seem to be involved," Espinola-Klein said.

But Dr. Paul Ridker, director of the Center for Cardiovascular Disease Prevention at Brigham and Women's Hospital in Boston, said the link may not necessarily mean that infections cause heart disease.

They could just be a marker for something else. For example, Ridker said in a commentary, people with a lot of infections could be in poorer health in general.

Ridker, who also studies links between infection and heart disease, has found that healthy people with high levels of inflammatory cells are more likely to develop heart disease.

"Our results suggested that inflammation seems to be a fundamental issue," he said, and noted that other studies indicate that aspirin and cholesterol-lowering statin drugs may prevent heart disease at least in part by reducing inflammation.

Last November, a Swedish team reported in the Journal of the American Medical Association that elevated levels of interleukin 6, one of the body's inflammatory signaling chemicals, could predict deaths from heart disease.

And last February an Austrian team reported that people who get infections over and over again, such as sinus infections or bronchitis, may also be more prone to clogged arteries.

But although several studies have linked infection with heart disease, none has shown that people who took antibiotics had a lower risk of heart disease.