Hyperbaric Oxygen: Therapeutic Uses - More Indications Than Many Doctors Realize

Kindwall, Eric P from "British Medical Journal"
August 28, 1993 v307 n6903 p515(2)

Subjects: Hyperbaric oxygenation Therapeutic use

Many British doctors are ignorant of the indications for hyperbaric oxygen and skeptical of its benefits, according to a recent survey of hyperbaric oxygen facilities. The survey, by the BMA's Board of Science and Education, concluded that given the present level of use then provision was sufficient, although doctors may be underusing the treatment.[1]

They need to know for which conditions hyperbaric oxygen works and refer accordingly. The telephone advisory service, run by the Institute of Naval Medicine at Gosport (similar to the National Poisons Unit help line), should be better known.

Treatment with hyperbaric oxygen was introduced as an adjunct to cardiovascular surgery before cardiopulmonary bypass techniques and deep hypotheria became available. But when surgery in a hyperbaric chamber was no longer necessary most of the original researchers stopped studying it. Britain helped to pioneer the use of hyperbaric oxygen to treat carbon monoxide poisoning, refractory osteomyelitis,[2] and compromised skin grafts. But with no formal training programs and little funding, the treatment now attracts little attention in Britain.

When administered at pressures greater than one atmosphere, oxygen can assume properties more akin to a drug than a simple support for metabolism. In carbon monoxide poisoning, for example, it stops lipid peroxidation, which spares neuronal cell membranes.[3]

It reduces odema by about 50% in post ischaemic muscle through preserving adenosine triphosphate.[4] In acute burns it reduces fluid requirements by 35% in the first 24 hours, thus reducing oedema.[5-8] It reduces white cell adhesion to capillary walls after ischaemic or traumatic insult, mitigating the no reflow phenomenon.[9] Red cell flexibility is doubled in about 15 treatments.[10] White cell killing of aerobic bacteria and some fungi is greatly enhanced at high oxygen pressures,[11] facilitating control of osteomyelitis[12] and reducing the number of operations and mortality in necrotising fasciitis.[13] Extremely important is its stimulation of new capillary and collagen formation in radiated tissue, normalising tissue oxygen tensions to permit surgery, healing, and even bone grafting.[14 15]

Finally, it increases tissue levels of superoxide dismutase, which counters the formation of free radicals after injury, resulting in better tissue survival.[16] This is particularly important in cursh injury, replants, and grafts, where free radical formation is responsible for reperfusion injury.[17]

Although many doctors believe that good research on hyperbaric oxygen is rare, the converse is true.[18-22] Over 3800 papers have been published on the topic despite the relative scarcity of chambers. The Undersea Medical Society began investigating the claims being made for hyperbaric oxygen treatment in 1977. A committee (which I chaired) considered 64 different allegedly improved by treatment with hyperbaric oxygen. In most of them there was insufficient evidence to warrant its clinical use.

In preparing out original report we consulted the largest private insurers in the United States, Blue Cross/Blue Shield, and the Federal Health Care Finances Administration. Since then the report has been continually updated. At present only 12 conditions are approved by the society for reimbursement.[23] Since 1977 the number of clinical chambers in the United States has grown from 37 to nearly 300.

For inclusion on the approved list there had to have been controlled studies or large clinical series indicating not only the efficacy but also the cost effectiveness of treatment with hyperbaric oxygen. In disorders for which prospective controlled trials were impossible or unavailable, evidence adduced for the efficacy of hyperbaric oxygen had to be at least as convincing as that used to support reimbursement of other treatments routinely paid for the insurers. The five major British centres for the most part limit treatment to those disorders on the approved list, despite there being no regulation to that effect.

This list can serve only as a guide. Though quite useful in diabetic wounds, hyperbaric oxygen is only part of a program of total wound care. For some diabetic wounds hyperbaric oxygen is inappropriate if the large vessels distal to the trifurcation at the knee are occluded or severely stenotic. Crush injury and impending compartment syndrome need to be treated immediately if any worthwhile result is to follow. Late referral, which gives time for oedema, reperfusion, and injury; free radical damage; and the no reflow phenomenon to do their work, makes the treatment largely a waster of time and money. For some surgical patients the potential dangers of further trauma to the wound during transportation will militate against the use of hyperbaric oxygen. Experience has shown, however, that patients with severe carbon monoxide poisoning can be transported safely over long distances in a properly equipped ambulance or helicopter.

Before transfer a critically ill patient is contemplated it should be ascertained that the receiving chamber facility can deliver the necessary level of intensive care. Whenever the use of hyperbaric oxygen is considered, consultation with the physician in charge of the hyperbaric oxygen facility is mandatory to ensure that referral is appropriate. The timing of hyperbaric oxygen in relation to surgery is also critically important. For example, in necrotising fasciitis, surgery is the accepted primary treatment, with hyperbaric oxygen used as a follow up. With gas gangrene, however, the hyperbaric chamber is used before surgery (other than for fasciotomy). In the treatment of radionecrosis the patient should be treated at least 20 to 30 times in the chamber, to induce the formation of new capillaries, before elective surgery is performed if healing is to be expected.

NOTES

[1] BMA Board of Science and Education. Clinical hyperbaric medicine facilities in the UK London: BMA, 1993.
[2] Perrins DJD, Maudsley RH, Colwil MR, Slack WK, Thomas DA. OHP in the management of chronic osteomyelitis. In: Brown IW, Cox BG, eds. Proceedings of the third international conference on hyperbaric medicine. Washington, DC: National Academy of Sciences, National Research Council, 1966:578-89. (Publication 1404.)
[3] Thom SR. Antagonism of carbon monoxide-mediated brain lipid peroxidation by hyperbaric oxygen. Toxicol Appl Pharmacol 1990;105:340-4.
[4] Nylander G, Lewis D, Nordstrom H, Larsson J. Metabolic effects of hyperbaric oxygen in post-ischemic muscle. Plast Reconstr Surg 1987;79:91-6.
[5] Cianci P, Leuders HW, Lee H, Shapiro RL, Sexton J, Williams C, et al. Adjunctive hyperbaric oxygen therapy reduced length of hospitalization in thermal burns. J Burn Care Rehabil 1989;19:432-5.
[6] Nylander G, Nordstrom H, Eriksson E. Effects of hyperbaric oxygen on oedema formation after a scald burn. Burns 1984;10:193-6.
[7] Stewart RJ, Yamaguchi YT, Cianci PA, Knost PM, Samadani S, Mason SW et al.The effects of hyperbaric oxygen on adenosine triphosphate in thermally injured skin. Surgical Forum 1988;39:87-90.
[8] Wells CH, Hinton JG. Effects of hyperbaric oxygen on post-bur plasma extravasation. In: Davis JC, Hunt TK (eds). Hyperbaric oxygen therapy. Bethesda, Maryland: Undersea Medical Society, 1977:259-65.
[9] Zamboni WA, Roth AC, Russell RC, Graham B, Suchy H, Kucan JO. Morphological analysis of the microcirculation during reperfusion of ischemic skeletal muscle and the effect of hyperbaric oxygen. Plast Reconstr Surg 1993;1110-23.
[10] Mathieu D, Coget J, Vinckier F, Saulnier A, Durocher ET, Wattel F. Red blood cell deformability and hyperbaric oxygen. Med Subaquatique Hyperbar 1984;3:100-4.
[11] Mader JT, Brown GL, Gluckian JC, Wells CH, Reinarz JA. A mechanism for the amelioration by hyperbaric oxygen of experimental staphylococcal osteomyelitis in rabbits. J Infect Dis 1980;142:915-22.
[12] Davis JC, Heckman JD, DeLee JC, Buckwold FJ. Chronic non-hematogenous osteomyelitis treated with adjuvant hyperbaric oxygen. J Bone Joint Surg [Am] 1986;68:1210-7.
[13] Riseman JA, Zamboni WA, Curtis A, Graham DR, Konrad HR, Ross DS. Hyperbaric oxygen therapy for necrotising fasciitis reduced mortality and the need for debridements. Surgery 1990;108:847-50.
[14] Marx RE, Johnson RP. Problem wounds in oral and maxillofacial surgery: the role of hyperbaric oxygen. In: Davis JC, Hunt TK, eds. Problem wounds: the role of oxygen. New York: Elsevier Science Publishing, 1988:65-125.
[15] Marx RE, Johnson RP, Kline SN. Prevention of osteroradionecrosis: a randomised prospective clinical trial of hyperbaric oxygen versus penicillin . J Am Dent Assoc 1985;111:490-554.
[16] Kaelin CM, Im MJ, Myers RA, Manson PN, Hoopes JE. The effects of hyperbaric oxygen on free flaps in rats. Arch Surg 1990;125:607-9.
[17] Manson PN, Anthenelli RN, Im MJ, Bulkley GB, Hoopes JE. The role of oxygen-free radicals in ischemic tissue injury in island skin flaps. Ann Surg 1983;198:87-90.
[18] Davis JC. Hyperbaric oxygen therapy. Intensive Care Med 1989;4:55-7.
[19] Goulon M, Barois A, Rapin M, Nouilhat F, Grosbuis S, LaBrousse J. Intoxication oxycarbonee et anoxie aigue par inhalation de gaz de charbon et hydrocarbures. Am Intern Med 1969;120: 335-49.
[20] Hart GB, Lamb RC, Strauss MB. Gas gangrene 1: a collective review. J Trauma 1983;23:991-5.
[21] Kindwall EP. Uses of hyperbaric oxygen therapy in the 1990s. Cleve Clin J Med 1992;59: 517-28.
[22] Strauss MB, Hargens AR, Gershuni DH, Greenberg DA, Crenshaw AG, Hart GB, et al. Reduction of skeletal muscle necrosis using intermittent hyperbaric oxygen in the model compartment syndrome. J Bone Joint Surg [Am] 1983;65:65-62.
[23] Thom SR. Hyperbaric oxygen therapy: a committee report. Bethesda: Undersea Hyperbaric and Medical Society, 1992.