The present state of hyperbaric oxygen therapy in the United States

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Modern hyperbaric oxygen therapy began in the United States with the installation of chambers at Duke University and at Mt. Sinai Hospital in New York City.

This was followed in the early 1960's with the construction of several large hyperbaric facilities, all capable of being used for surgery under pressure, the idea based on the pioneering work of Professor Ite Boerema of Amsterdam. As you well know, the construction of large surgical chambers is extremely expensive, but the resurgence of modern hyperbaric oxygen therapy began with the needs of the surgeons.

By the early 1970's, a number of these large surgical facilities had either closed or become inactive because of the great advances in heartlung machines and by-pass surgery.

For a number of years, it was impossible to justify the large surgical facility because of its need in the surgical correction of congenital cyanotic heart disease. Here, the heart-lung machine could often not be used because the priming volume for the pump was greater than the patient's total blood volume. By 1974, however, very deep hypothermia had made it possible to operate on these children even without the aid of either the pump or the chamber. Thus, the absolute indications for surgery under hyperbaric conditions became smaller and hospital administrators found it increasingly more difficult to justify the expense of maintaining large hyperbaric chambers.

Another problem during this period of time was the over-enthusiasm of many physicians for what hyperbaric oxygen could do. Too often, results of preliminary research were released to the lay press where the effects of hyperbaric oxygen were exaggerated out of all proportion.

Physicians were happy to try this new tool on almost any disease process, as in trained hands, the therapy was non-invasive and appeared to do little harm. Few contraindications for this treatment were recognized. In their enthusiasm, few objective measurements were made and there were not enough controlled studies. Because carbon monoxide poisoning and gas gangrene had responded so dramatically to chamber treatment, many physicians psychologically expected or at least hoped that disorders ranging from stroke to cancer to a host of degenerative diseases would respond in a similar dramatic fashion. When these hopes were not realized and there were little objective or clinical data recorded to demonstrate less dramatic change in other diseases, most of the medical profession lost interest in the hyperbaric chamber. It was acknowledged to be helpful in gas gangrene, diving accidents and carbon monoxide poisoning but entirely too expensive to operate or maintain except in large hospitals or medical centers. Where surgical chambers already existed, a few continued to be used for surgery in critically ill patients but no new surgical chambers were constructed after about 1969. The early 1970's was a difficult period for hyperbaric medicine as the surgical use of chambers declined and hospital administrators demanded justification of costs for existing chambers. Nevertheless, a small group of dedicated and competent researchers continued to experiment with the chamber and gradually accummulated enough animal and human data

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from control studies to show that hyperbaric oxygen, although often not dramatic, could be of cost-effective benefit in a number of different clinical conditions unrelated to diving. This work was necessarily slow for several reasons. First, it was hard to induce young physicians to enter this field. It had no recognition as a medical specialty, and there was no hyperbaric oxygen society to function as a forum for the exchange of information among researchers. Proof of the effectiveness of hyperbaric treatment in a number of situations was still lacking and it was easy for the young physician to see that when he left the large medical center where the chamber was located, he would be unable to prescribe hyperbaric treatment for his patients in practice. Because of the lack of specialty status and even the lack of a simple text book in the field, there were no formal training programs for those who conceivably might be interested in hyperbaric therapy. Even those hospitals that could afford hyperbaric facilities were often unable to find qualified physicians to direct them.

The only source of training in the use of hyperbaric chambers was in the military where submarine medical officers were taught solely the problems of divers. Even though equipped with a basic background in chamber operation, these young medical officers typically entered specialties unrelated to diving medicine on leaving military service.

But after 1975, hyperbaric oxygen therapy experienced a rapid growth once again. One of the most important factors was the increasing popularity of the monoplace chamber.

It was originally introduced in the early 1960's by the Vickers Company to be used as an adjunct to radiation therapy. A number of these chambers were purchased in the United States by radiation therapists but, largely because of the differences in the dose fractionation between British and American radiation therapy protocols, American therapists became disenchanted with its use. These chambers were often relegated to the storeroom when the original investigator ceased doing radiation therapy under hyperbaric conditions. Nevertheless, it was eventually discovered that the monoplace chamber could be used for hyperbaric treatment of those conditions already treated in the large multiplace chambers. These included chronic osteomyelitis, osteoradionecrosis, soft tissue radionecrosis, skin grafts and flaps and burns. Many physicians trained in the military found it difficult to accept the monoplace chamber because there was no way to "get at" the patient during treatment if his condition suddenly warranted it. Even though one could decompress the patient within a minute with no danger from decompression sickness, physicians psychologically had a difficult time accepting this form of treatment. Additionally, those patients who required respirators, intensive monitoring and intravenous therapy were not considered suitable for treatment in the monoplace chamber.

However, largely through the efforts of Dr. George B. Hart at the United States Naval Medical Center at Long Beach, California, these problems were addressed and overcome. Now, using the monoplace chamber, it is possible to continuously give intravenous fluids, achieve monitoring of any kind and with the development of improved ventilators, the apneic patient can be successfully managed in the monoplace chamber.

An American version of the British Vickers chamber became available about 1975 and after a slow start, its production has increased considerably. The real importance of the monoplace chamber however, was that it could be afforded by the average community hospital and set up in an existing patient room with almost no modification. No expensive and heavy compressors were required as oxygen came directly from the hospital's built-in oxygen system and the chamber could be effectively operated by existing nurses and respiratory therapists. Essentially, hyperbaric medicine under such circumstances became an extension of the existing services of the departments of inhalation therapy. For this reason, doctors trained in large medical centers in hyperbaric medicine could foresee a use for this knowledge even when finished with their training and practicing in smaller general hospitals. It is now felt that about 90% of what can be accomplished in the large walk-in chamber can be done successfully in the

oxygen-filled monoplace chamber.

The next most important advance had to do with the politics of medicine. Some physicians and a number of non-physicians, had set up hyperbaric "clinics" and continued to exaggerate the indications for hyperbaric therapy. There have been a number of sensational articles in the lay press including direct advertisements of HBO to the public.

Organized medicine took a dim view of these activities and physicians often would categorically reject any suggestion of hyperbaric treatment for their patients because of the activities of some of these "clinics".

In 1976 the Undersea Medical Society realized that as there existed no hyperbaric society in the United States to take responsibility for this growing field, it had a moral duty to assume it. By this time, a number of responsible investigators in the field of hyperbaric medicine had been advocating a hyperbaric society. However, it was felt that creating a second group in addition to the Undersea Medical Society would be devisive and a duplication of efforts in a number of areas. Thus, responding to complaints that hyperbaric oxygen therapy was being misused by some practitioners, and in order to provide guidelines to medical insurance companies, the Undersea Medical Society created a committee on hyperbaric oxygenation to investigate the whole field of oxygen therapy under pressure in November of 1976. As chairman of that committee, I invited some 18 prominent researchers and clinicians in the field, often drawn from the military and from university centers, to join the committee.

After consulting with the largest private medical insurance carrier in the United States, Blue Cross-Surgical Care Blue Shield, and also with the government medical insurance agencies, the committee produced its report in May of 1977. This report has been updated yearly since that time.

The committee categorized all diseases which had been treated in the hyperbaric chamber or which had been described as benefiting from HBO in the lay press, into four categories. These categories were based on the amount of evidence available for the efficacy of hyperbaric oxygen therapy.

CATEGORY I.

This group includes disorders for which hyperbaric oxygen is the primary mode of treatment, and other measures are adjunctive, and also includes conditions for which hyperbaric oxygen may be adjunctive but for which the research and clinical experience has been so extensive that little or no doubt about the efficacy of HBO remains. The committee feels strongly that Category I disorders should be reimbursable by third party insurers.

1. Anemia, Exceptional Blood Loss
2. Carbon Monoxide Poisoning, Acute
3. Cyanide Poisoning, Acute
4. Decompression Sickness
5. Gas Embolism, Acute
6. Gas Gangrene
7. Skin Grafts and Flaps, Compromised
8. Smoke Inhalation with Presumption of Carbon Monoxide or Cyanide Poisoning
9. Ulcer, Meleney

CATEGORY II.

Disorders for which animal data or clinical experience are compelling, but for which the number of controlled studies and/or the amount of clinical experience is less than that for Category I are included in this group. The committee looks forward to receiving further clinical data supporting HBO therapy for disorders in this category, but feels that the evidence is substantial enough at the present time to warrant third party reimbursement for treatment within the strict constraints specified for each disorder.

1. Actinomycosis
2. Arterial Insufficiency, Acute Peripheral
3. Bacteroides Infections
4. Crush Injury
5. Edema, Acute Cerebral
6. Head and Spinal Cord Injury, Traumatic
7. Intestinal Obstruction
8. Osteomyelitis, Refractory
9. Osteomyelitis, Early, Non-Refractory

10. Osteoradionecrosis
11. Peripheral Ischemia, Acute Traumatic
12. Radionecrosis, Soft Tissue
13. Retinal Artery Insufficiency, Acute, Central
14. Retinopathy, Hyperbaric Oxygenation as an Adjunct to Scleral Buckling Procedures in Patients with Sickle Cell Peripheral Retinopathy and Retinal Detachment
15. Surgical Adjunct: Vascular Surgery, Cardiac Surgery and Surgery in the Severely Ill (High Surgical Risk)
16. Suturing Severed Limbs
17. Thermal Burns, Acute
18. Ulcer, Skin, Chronic, Secondary to Arterial Insufficiency
19. Ulcer, Stasis

CATEGORY III.

Disorders for which HBO animal studies or preliminary clinical trials have shown promise or for which there is a good theoretical indication are included in this section. However, definitive evidence that HBO is as effective as or superior to other forms of therapy is inadequate for these conditions, either because the data are conflicting or insufficient. The committee feels that disorders in this category should not be reimbursable by third party insurers.

1. Aerobic Infections, Systemic
2. Cerebrovascular Accident, Acute (Thrombotic or Embolic)
3. Cerebrovascular Accident, Hemorrhagic
4. Emphysema
5. Emphysema, Subcutaneous
6. Fracture Healing
7. Frostbite
8. Genococcal Infections
9. Headache, Migraine
10. Lepromatous Leprosy
11. Meningitis
12. Mucormycosis
13. Myocardial Infarction without Shock
14. Myocardial Infarction with Shock
15. Necrosis, Hepatic
16. Organ Storage
17. Post Anoxic State Following Asphyxia
18. Post Anoxic State Following Near Drowning
19. Pulmonary Insufficiency (Temporary, Life Threatening)
20. Radiation Enteritis
21. Scleroderma
22. Senility (Cerebral Insufficiency Secondary to Arthrosclerosis)
23. Sickle Cell Crisis
24. Sickle Cell Hematuria
25. Stroke, Chronic
26. Tetanus
27. Ulcers, Decubitus
28. Ulcer, Gastric
29. Ulcers, Skin, Chronic Trophic
30. Ulcer, Skin, Diabetic
31. Vascular Insufficiency, Chronic Peripheral
32. Vertigo-On Basis of Cerebral Insufficiency

CATEGORY IV.

Disorders for which only hearsay evidence that HBO is of any benefit or for which no theoretical basis for treatment exists are combined in this category. It is conceivable that some disorders in this group may some day be found to benefit from hyperbaric oxygen therapy; others are clearly "wishful thinking" and the use of HBO for their treatment at present is not scientifically or medically indicated. These disorders are listed in the interests of objectivity and fairness and many are included simply to record that they were considered in the committee's deliberations.

1. Arthritis
2. Breast Firming and Enlargement
3. Hair Color, Restoring Normal
4. Hypertension
5. Multiple Sclerosis
6. Sexual Vitality, Restoration of
7. Skin Wrinkles

Categories I and II were felt to be well enough proven to warrent insurance payment by the medical insurance companies including the federal government, and 28 disorders were placed in these categories. Category III was considered to be a research area and hyperbaric treatment was not to be paid for in this category by insurance

companies. Currently, there are 32 disorders listed in Category III. Category IV was felt to have little if any scientific evidence to support the use of hyperbaric oxygen at this time and 7 disorders were listed in that category. Copies of the index of that report are attached. This index is the most recent revision of the report and is dated September, 1979. Blue Cross-Surgical Care Blue Shield accepted the Hyperbaric Oxygen Therapy Committee's report on September 14, 1977 in its entirety. At the present time, the United States goverment medical insurance agency (Medicare) has accepted 12 of the 28 disorders in Categories I and II and the acceptance of the remainder is pending.

It is expected that as more research data become available, certain disorders may be added or dropped in the various categories and this document can only be useful to physicians, hospital administrators and medical insurers if updated annually. At present there are about 90 hyperbaric chambers operational in the United States, many of them now being monoplace hyperbaric units. New units are becoming operational at the rate of about one per month. The treatment of decompression sickness and air embolism are still considered to be best treated in the multiplace units but much more commonly, radionecrosis, chronic refractory osteomyelitis and wound healing problems are being treated in the monoplace chamber. Our hospital now offers a one week training course for physicians in hyperbaric medicine and we also offer courses for hyperbaric chamber operators. Similar courses are offered at the Long Beach Memorial Hospital at Long Beach, California and at Methodist Hospital in San Antonio, Texas. It is hoped that as more hyperbaric chambers become available, other centers will begin to offer training courses for physicians. Eventually, hyperbaric oxygen may become a sub-specialty of pulmonary medicine, anesthesia or one of the surgical specialties.

With the advent of the book Hyperbaric Oxygen Therapy, edited by Colonel Jefferson C. Davis, Medical Corps, United States and Professor Thomas K. Hunt, Professor of Surgery at the University of California (San Francisco) and published by the Undersea Medical Society in 1977, the field of hyperbaric oxygenation acquired a basic textbook. This volume is now in its second printing. The appearance of this text and the report of the Committee on Hyperbaric Oxygenation has, since 1977, made hyperbaric oxygen therapy a legitimate and well defined field within clinical medicine. It now has a scientific foundation and a specific list of indications. It is this foundation upon which the specialty will grow.

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