

Hyperbaric Oxygen Therapy - IAM Experience A Review of Past Forty Years Cases

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Abstract

This a retrospective study specifically aimed to cover the complete gambit of illness/ indications for which Hyperbaric Oxygen Therapy (HBOT) was given at this Institute. The data collected was also analyzed on various criteria to get trends of clientele at IAM. HBOT is a form of treatment in which a patient breathes 100% oxygen greater than 1 Atmosphere Absolute Pressure (ATA). Over the past 40 years (Jan 1973 – Jun 2013), hyperbaric oxygen therapy has been used in a wide variety of medical conditions. The analysis of data brings out some interesting trends. The data held at Dept of High Altitude Physiology and Hyperbaric Medicine (HAP&HM), was compiled and observed that 1540 cases were treated with HBOT, with an average of 37 cases being treated every year. Based on the data obtained at the beginning of the treatment, the cases were classified into various groups based on diagnosis like Non-healing ulcers, SNHL, Vascular, Post radiation, CVA, Dental etc. The data was also classified based on the client population. There was a varied type of clientele comprising mainly of civilians. Serving personnel, retired personnel and their dependents were also treated. Out of 1540 cases treated at this Institute, 889 (63.45%) improved, 444 (31.69%) could not be followed up. For 40 (2.85%) patients HBOT was interrupted due to reasons like discontinuation as advised by treating physicians, development of symptoms in chamber etc and only 5 (0.35%) did not show any signs of consisted improvement. The majority of the cases treated of 362 (25.83%) cases of Non Healing Wounds 258 (18.41%) cases of vascular disorder, 155 (11.06%) cases of SNHL and 118 (8.42%).

IAM experience over a span of four decade indicates that addition of HBO therapy to conventional treatment modalities significantly improves the outcome of various indicated diseases, especially non healing wounds, SNHL and Post radiation injuries.

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Introduction

Hyperbaric Medicine is use of increased barometric pressure for delivering increased oxygen dissolved in plasma to body tissues. HBOT is a form of treatment in which a patient breathes 100% oxygen at higher than normal atmospheric pressure that is greater than 1 atmosphere absolute (ATA). Therapy is given in special therapeutic chambers, which were earlier used primarily to treat illnesses of deep sea divers. Over the last five decades, animal studies, clinical trials and well-validated clinical experience has proved usefulness of HBO in several indications and there is recently a transformed concern in this field all over the world.

Acute traumatic wounds, crush injuries, gas gangrene are indications where addition of hyperbaric oxygen may be life and limb saving. Patients who have been suffering from non healing ulcers and all late consequence of radiation therapy show dramatic benefits with HBOT. Acute hearing loss and many neurological illnesses are now almost certainly known to benefit from HBOT. With ongoing growth all over the world, Hyperbaric Medicine has found a distinct role in the contemporary era of evidence-based medicine.

In major conditions, as with heart attacks or

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strokes, the amount of oxygen being carried by the blood may be normal but the tissues of the heart or brain are dying of hypoxia - lack of oxygen. A controlled trial in California has shown that when the latest clot busting drugs are given together with hyperbaric oxygenation, the benefit is dramatic [1].

This is a retrospective study specifically aimed to cover the complete gambit of illness/indications for which HBO therapy was given at this centre (Dept of HAP & HM).

Method

The patients included in this study have received routine HBOT in hyperbaric chamber at IAM over last 40 years. Total number of cases studied was 1540. The data was obtained from the medical record books maintained at the Department of High Altitude Physiology and Hyperbaric Medicine (HAP&HM). Based on the data obtained at the beginning of the treatment, the cases were classified in to various groups like Non-healing ulcers, SNHL, Vascular, Post radiation, CVA, Dental etc. The data was also classified based on the clientele population, their outcome, yearly trends etc. There was a varied type of clientele comprising of civilians, serving, retired personnel and their dependents. The data was analyzed for different parameters.

Results

The data of the treated cases were analyzed on various grounds like category, diagnosis, referral, outcome, yearly trends. The classification of cases as per diagnosis is given Table-1 and Figure 1 . The male to female ratio is given in Table-2.

Majority of the patients treated for HBOT were civilians (52.34%). It is interesting to note the number of personnel treated and the category which they belong with age. Table to denote the

Table 1: Classification of cases as per Diagnosis

SI No	Diagnosis	Cases	% age
1	Non Healing Wounds	362	23.51
2	No Diagnosis	258	16.75
3	Vascular	258	16.75
4	SNHL	155	10.06
5	Post Radiation	118	7.66
6	CVA	66	4.29
7	Osteomyelitis	57	3.70
8	Cold Injuries	47	3.05
9	Infective	44	2.86
10	Miscellaneous	43	2.79
11	Multiple Sclerosis	24	1.56
12	Fractures	34	2.21
13	Fascitis	4	0.26
14	Dental	43	2.79
15	Research Runs	14	0.91
16	IHD	13	0.84
	Total	1540	100.00

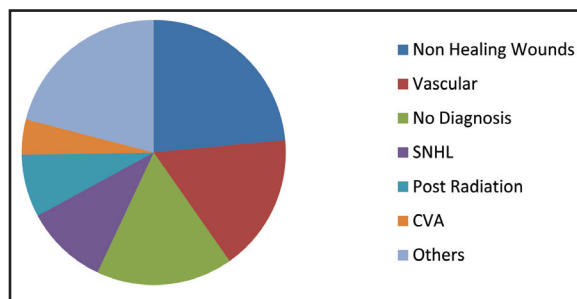


Figure 1: Classification of cases as per Diagnosis

Table 2: Male to female ratio

Gender	Number	Percentage
Females	290	18.8
Males	1250	81.2
	1540	100

percentage of personnel treated as per category is shown in Table-3. The outcome as per category is shown in Table-4 and Figure 3.

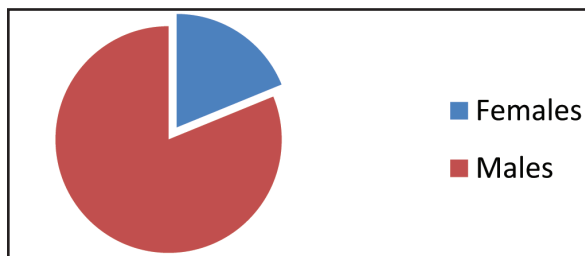


Figure 2: Male to female ratio

Table 3: Classification of cases as per category

Sl No	Category	Cases	% age
1	Serving	531	34.48
2	Dependent	120	7.79
3	Retired	83	5.39
4	Civilian	806	52.34
	Total	1540	100.00

Table 4: Classification as per outcome

Sl no	Outcome	No	Percentage
1	Improved	889	57.73
2	Not improved	5	0.32
3	No follow up	583	37.86
4	Died	3	0.19
5	Interrupted	40	2.60
6	Research Run	20	1.30
	Total	1540	100.00

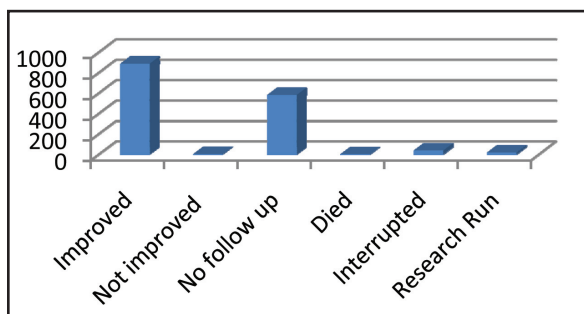


Figure 3- Distribution as per outcome

Table 5: Classification as per years versus referral centers

Year	Service	Non-Service	Total
1973	47	0	47
1974	6	0	6
1975	21	0	21
1976	20	3	23

Year	Service	Non-Service	Total
1977	21	2	23
1978	5	1	6
1979	46	4	50
1980	16	3	19
1981	10	8	18
1982	18	2	20
1983	16	8	24
1984	5	8	13
1985	20	25	45
1986	33	19	52
1987	82	27	109
1988	22	13	35
1989	13	10	23
1990	26	12	38
1991	39	35	74
1992	34	2	36
1993	28	2	30
1994	64	9	73
1995	20	22	42
1996	26	26	26
1997	9	27	36
1998	4	19	23
1999	7	9	16
2000	16	35	51
2001	5	21	26
2002	6	24	30
2003	5	26	31
2004	16	16	32
2005	21	18	39
2006	2	39	41
2007	9	49	58
2008	13	43	56
2009	5	40	45
2010	10	52	62
2011	17	56	73
2012	10	40	50
2013	4	14	18
			1540

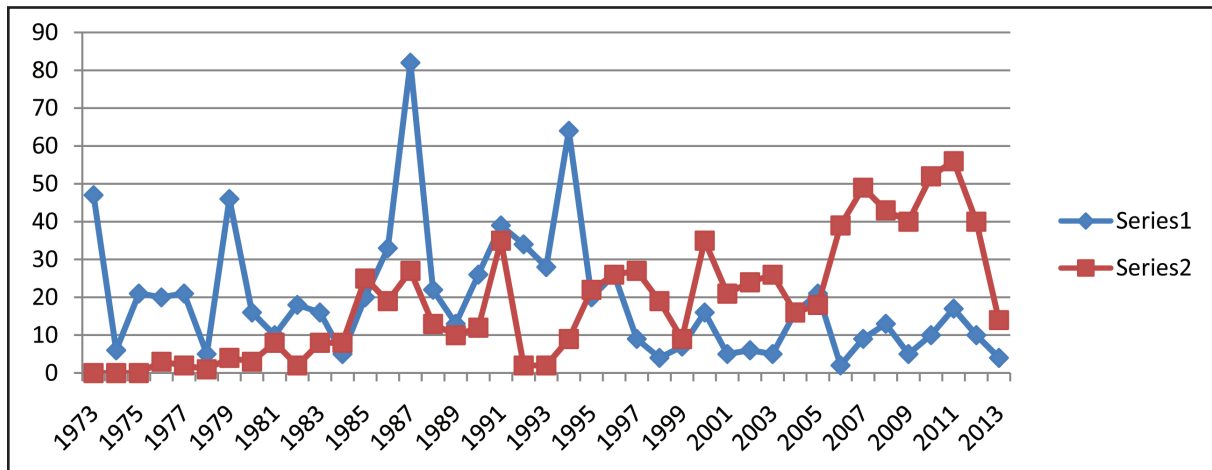


Figure 5: Trends of cases based on referral center

Classification as per years versus referral centres is given in Table 5. The trend of cases based on civil or service personnel depending on the centre from which they are referred when plotted year wise showed the trend depicted in Figure 5.

Discussion

Although the clinical history of hyperbaric medicine dates back to the 17th century, reports of the beneficial effects of increased oxygen pressure on wound healing and infection did not appear in the medical literature until the 1960s. The most recent report by the Hyperbaric Oxygen Therapy Committee of the Undersea and Hyperbaric Medical Society lists several indications for hyperbaric oxygen (HBO) therapy that are directly applicable to lower-extremity pathology. These include Clostridial Myonecrosis, Acute Traumatic Ischemia, enhancement of healing in problem wounds, necrotizing soft tissue infections, Refractory Osteomyelitis, compromised skin grafts and flaps, and thermal burns. Interestingly, there are relatively few controlled clinical trials in human subjects involving HBO for the treatment of these conditions. In fact, the majority of published reports on this topic consist of review articles, case reports, uncontrolled studies, and animal or in vitro studies.

Physiological Basis

When we normally breathe air at sea level pressure, most tissue needs for Oxygen are met from the Oxygen combined to Hb, which is 95 % saturated. 100 ml blood carries 19 ml O₂ combined with Hb and 0.32 ml dissolved in plasma. At this pressure, if 100% O₂ is inspired, O₂ combined with Hb increases to a maximum of 20 ml and that dissolved in plasma to 2.09 ml. The higher pressure during hyperbaric oxygen treatment pushes more oxygen into dissolved form in plasma. The amount of O₂ dissolved in plasma increases to 4.4 ml/dl at a pressure of 2 ATA and to 6.8 ml/dl at 3 ATA. This additional O₂ in plasma is almost sufficient to meet tissue needs without contribution from O₂ bound to hemoglobin and is responsible for most of the beneficial effects of this therapy [1,2,3,5].

The application of HBO to the therapy of various human diseases developed over a 300 year period. Like most of medicine, the basis of this application was and continues to be pragmatic in nature, and involves uncritical and untested judgments [4].

HBOT has been found beneficial not only by increasing the amount of dissolved oxygen but also by other mechanisms like:

1. Vasoconstriction leading to edema reduction
2. Neo vascularization
3. Bacteriostatic and bactericidal effect
4. Epithelialization

IAM Experience

The overall experience at IAM points out to the fact that use of HBOT is definitely beneficial for the UHMS indicated diseases. On analyzing the outcome, it was observed that improvement rate was 57%. However if the non followed up cases are added to this, rate is close to two third of the total cases. Though this cannot be proven statistically, being a retrograde study without control population, the results are definitely encouraging.

In the first two decades of the HBOT chamber mainly serving personnel or dependents were treated. However, in the overall data it is observed that the majority of the cases treated are civilians, accounting for 57.53%. This may be attributed due to loss of data.

Decade wise distribution

The analysis of trends based on the cases referred by service versus non-service hospital, it was found that in first two decades majority of the cases were referred from Service hospitals. In the last two decades the trend is reversed. It may be analyzed that this can be attributed to either increased awareness of HBOT in Non service hospitals due to proven benefits of HBOT or may be due to relative fall in the number of cases from service hospitals.

Table 6: Distribution of cases as per referral based on service or non service hospital

	Service Hospital	Non-Service Hospital	Total
Decade 1	226	31	257
Decade 2	302	153	455
Decade 3	162	218	354
Decade 4	107	367	474

HBOT in Non Healing Wounds

Many studies have been done on effects of HBOT on lower extremity wounds and diabetic foot. Two randomized studies included a control group that did not receive HBO therapy. The controlled diabetic foot studies included an average of 28 subjects in the HBO therapy group (range 10-62) and an average of 16.2 subjects in the non-HBO control group (range 5-33). Additional randomized placebo-controlled clinical trials in large diabetic populations would further lend credence to the presumption that HBO therapy improves clinical outcomes. Given the relatively high cost of this treatment modality, perhaps a more acute awareness of the medical literature would reduce the economic burden that HBO therapy imposes on care providers that are financially at risk [5]. HBOT, in conjunction with an aggressive multidisciplinary therapeutic protocol, is effective in decreasing major amputations in diabetic patients with severe prevalently ischemic foot ulcers [6].

The total cases treated at IAM for which records are available are 1540 over past four decades. The commonest disability treated was Chronic Non Healing Wounds. (23.51%). 38.3% of Non Healing wounds were Diabetic foot. Outcome of chronic wounds is shown in Table 6. This outcome is very closely comparable with other studies.

Table 7: Outcome of Cases Treated for Non Healing Wounds

Outcome	Cases	% age
Died	1	0.28
Improved	212	58.56
Interrupted	12	3.31
No Follow Up	135	37.29
Not Improved	2	0.55
Total	362	100.00

Ninety-four patients with Wagner grade 2, 3, or 4 ulcers, which had been present for >3 months, were studied [8]. In the intention-to-treat analysis, complete healing of the index ulcer was achieved in 37 patients at 1-year of follow-up: 25/48 (52%) in the HBOT group. At IAM chronic injuries were treated with at least 15 HBO₂ sessions [10].

HBOT in Post Radiation Osteoradionecrosis (Mandibular Osteoradionecrosis)

Because of the mandible's low vascularity and great density, the incidence of osteoradionecrosis is highest at this site. The mandible is often involved because head and neck cancers are common, and radiation therapy in these cancers is very effective. The presence of teeth in the jaws, as well as the functional and cosmetic importance of the mandible, means that osteoradionecrosis of the mandible most dramatically impacts on the patient's quality of life.

Osteoradionecrosis (ORN) of the mandible is a potential complication of head and neck irradiation. It is defined as a nonhealing, nonseptic lesion of bone (Clayman, 1997). The underlying cause of ORN is believed to be progressive vascular occlusion and tissue hypoxia after radiation treatment (Porter & Brian, 1999). Three types of ORN have been described. Type 1 occurs when a patient receives radiation therapy within 21 days of tooth extraction or mandibulotomy. Type 2 is induced by trauma. It generally occurs 3-6 years after radiation therapy, usually following a tooth extraction. Type 3 occurs spontaneously 6 months to 2 years after radiation therapy and is associated with higher radiation doses, neutron beam therapy and brachytherapy (Cronje, 1998). Hyperbaric oxygen therapy is generally accepted as a treatment for patients who have ORN. The use of hyperbaric oxygen therapy is also proposed as a prophylactic

treatment before dental work to prevent ORN in patients who have had irradiation of the head and neck.

The 1990 Consensus Paper of the National Cancer Institute on the Oral Complications of Cancer Therapies states: "The treatment of ORN with antibiotics and surgical debridement frequently fails, with progressive involvement of the remaining mandible. The keystone of the treatment of ORN is the provision of adequate tissue oxygenation in the damaged bone. This is best done by using Hyperbaric Oxygen Therapy (HBOT). In the event that dental extractions are required following radiation, meticulous surgical technique and antibiotic prophylaxis are necessary.

At IAM, 118 cases were treated with HBOT for post radiation injuries. Out of which 41 cases were of ORN. Majority of cases i.e. 37 cases were improved and 4 were not followed up.

HBOT in SNHL and Tinnitus

Idiopathic sudden sensorineural hearing loss (ISSHL) with or without tinnitus is common and presents a health problem with significant effect on quality of life. Hyperbaric oxygen therapy (may improve oxygen supply to the inner ear and thereby result in an improvement in hearing and/or a reduction in the intensity of tinnitus ⁹.

At IAM, a total 155 (10.06%) cases of SNHL were treated, out of which 105 improved. In 07 cases, treatment was interrupted due to various reasons, 41 cases were not followed up and only one did not improve.

Conclusion

IAM experience over a span of four decades indicates that the addition of HBO therapy to conventional treatment modalities significantly

improves the outcome of various indicated diseases, especially non healing wounds, SNHL and Post radiation injuries. It is found that there is association between outcome of the disease and number of sessions. It is recommended to maintain a data base programme at the department of HAP & HM for future analysis of such cases in a standardized and systematic manner.

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