

Inaugural meeting of
Asia Hyperbaric & Diving Medicine Association
(AHDMA : 2005)

April 2005



Kuala Lumpur , Malaysia

HYPERBARIC OXYGEN THERAPY IN ACUTE SENSORINEURAL HEARING LOSS(ASNHL)

Experiences in India's first tertiary care private hospital offering Hyperbaric Services

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Agenda

- Overview of the Hyperbaric Centre in New Delhi
- Etio-pathogenesis of Acute Sensorineural Hearing loss
- Case Reports
- Role of Hyperbaric Oxygen in Acute sensori neural Healing loss
- Literature Review
- Conclusion

India on the Hyperbaric world map

Land Locked Delhi National Capital

Started
Operations
In
June 2000



Indraprastha Apollo Hospital New Delhi

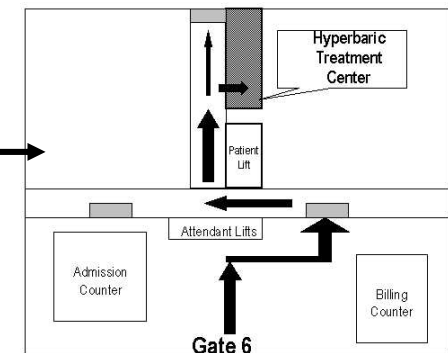


- **500 bed Superspeciality corporate hospital**
- **Site of India's First Private Hyperbaric Treatment Center**

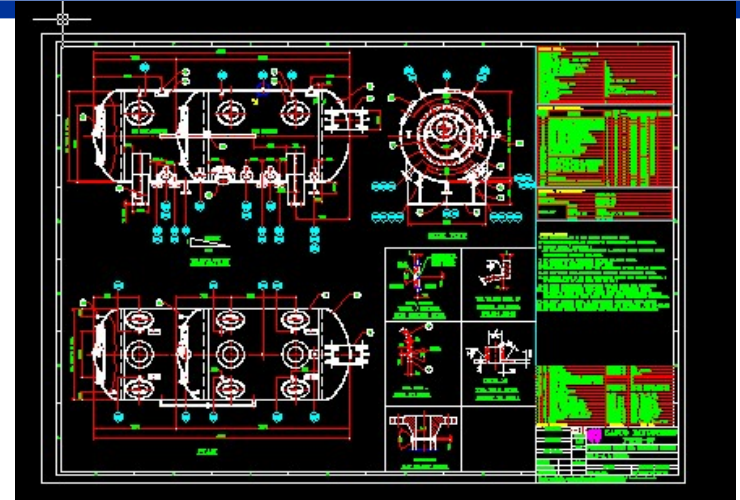
India on the Hyperbaric world map



Location Of Hyperbaric Treatment Centre



The Hyperbaric Chamber at Delhi



Location of the chamber

The Hyperbaric Chamber at Delhi : Easily Integrating with existing hospital services



Air and Oxygen Banks in
the basement



Air-Conditioning Plant
outside the treatment area

Over 100 M of pipeline carries Oxygen & Compressed air from the basement to the Treatment Chamber

Equipment

**Delegation of Responsibility for
standards**

Third Party Surveyors

***American Bureau Of
Shipping***



Certificate of Compliance

From ABS

Conforming to

ASME-PVHO I & NFPA

Standards

Equipment

The Hyperbaric Chamber at Delhi



Multiplace Hyperbaric Chamber at Apollo Hospital New Delhi

- Can take 2 lying + 2 sitting or 8 sitting patients
- Has a twin lock , so doctor can go in without disrupting treatment
- Temperature control
- CCTV
- Treatment for indications universally accepted .



Equipment

The Hyperbaric Chamber at Delhi

Oxygen Masks



- Designed for patient comfort
- Ensures 100 % delivery of Oxygen
- Needs a positive pressure during inspiration , amount of pressure is patient dependant
- Exhaled gases are released outside the treatment area



Oxygen Hoods

- Useful for patients who experience difficulty with mask
- Patient friendly , maintain eye contact
- Used in children



Indications for HBO Therapy

The Traditional Presentation

“Undersea & Hyperbaric Medical Society USA”

1. Air or gas embolism
2. Carbon monoxide poisoning / smoke inhalation
3. Clostridia myonecrosis (gas gangrene)
4. Crush injury, compartment syndrome, and other acute traumatic ischemias
5. Decompression sickness
6. Enhancement of healing in selected problem wounds
7. Exceptional blood loss (anemia)
8. Necrotizing soft tissue infections (subcutaneous tissue, muscle, fascia)
9. Osteomyelitis (refractory)
10. Radiation tissue damage
11. Skin grafts and flaps (compromised)
12. Thermal burns
13. Intracranial Abscess

“ European Undersea and Hyperbaric Medicine Society

ACUTE INDICATIONS

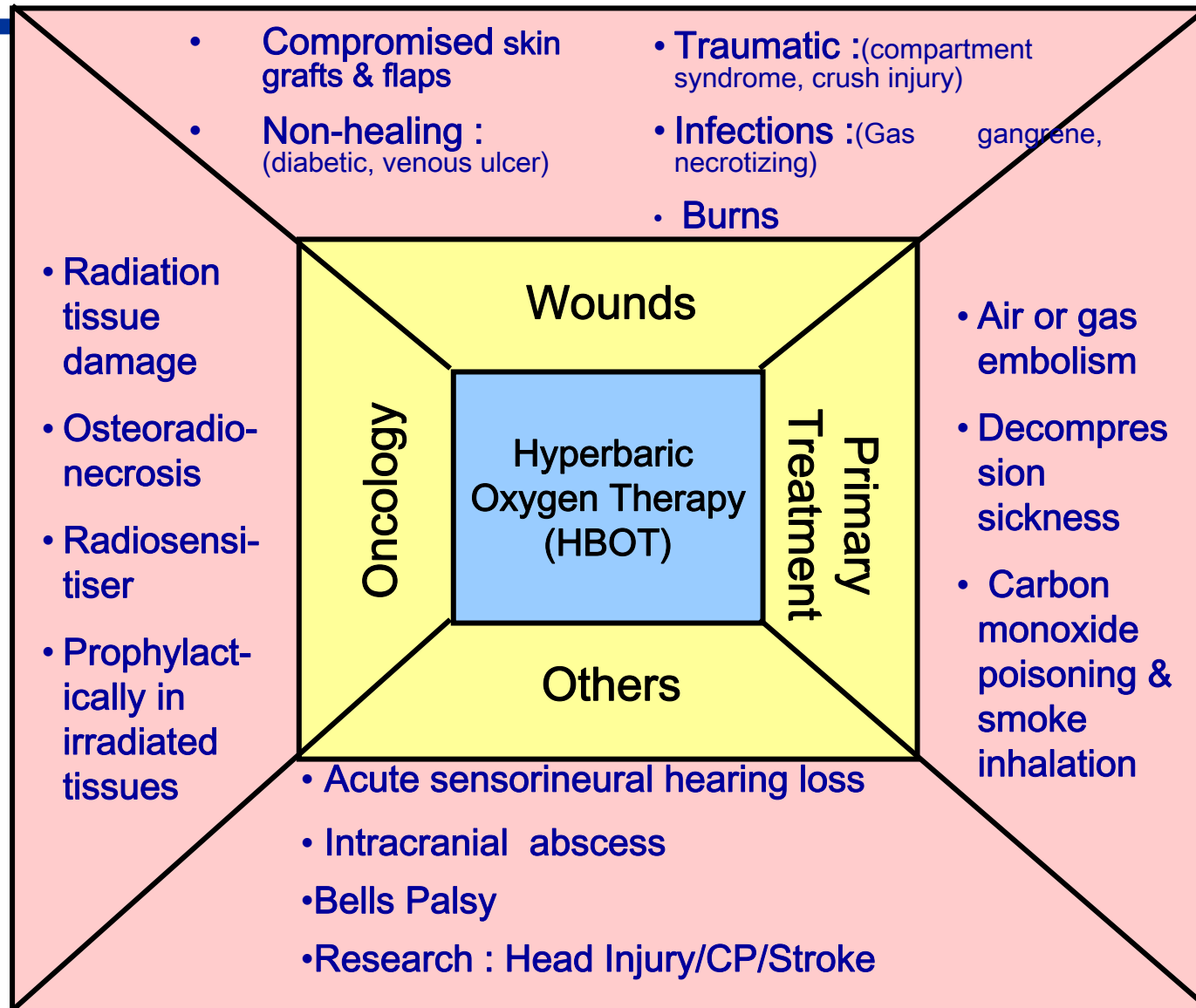
1. Carbon monoxide poisoning
2. Air or gas embolism
3. Soft Tissue Necrotising Infections
4. Acute traumatic ischemias (Crush injury, compartment syndrome, and others)
5. Post Anoxic Encephalopathy
6. Burns
7. Ocular Ischemic Pathology

CHRONIC INDICATIONS

1. Ischemic Lesion In Diabetes
- 2. Radiation tissue damage**
3. Skin grafts and flaps (compromised)
4. Chronic Osteomyelitis (refractory)

These indications are reimbursed by Insurance companies world wide

Applications of Hyperbaric Oxygen Therapy



HYPERBARIC OXYGEN THERAPY IN ACUTE SENSORINEURAL HEARING LOSS(ASNHL)



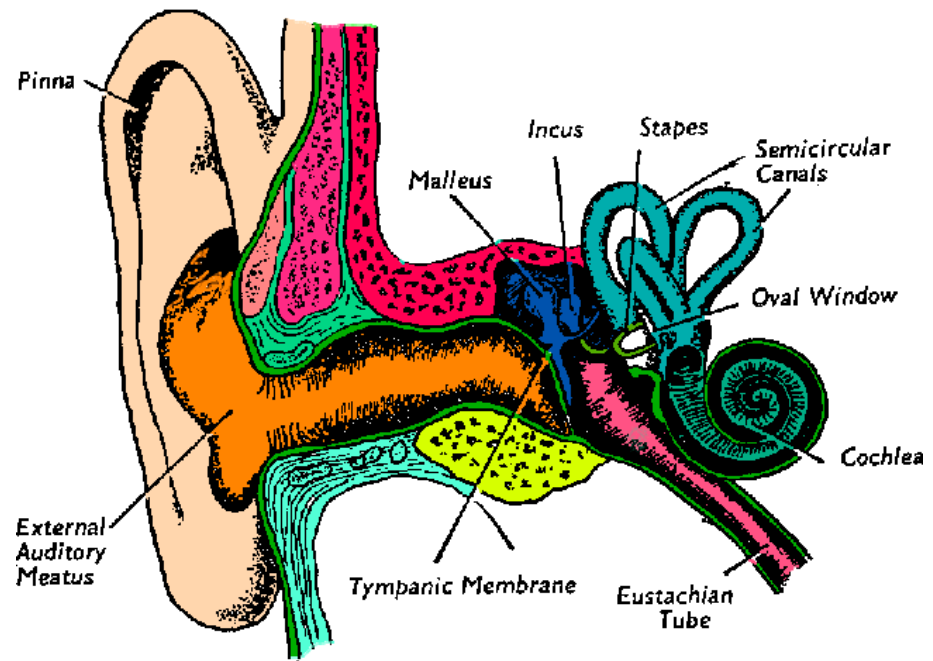
Case Reports : Feb 2005

Sudden sensorineural hearing loss

- **Definition**
- Hearing loss of rapid progression and unknown etiology
- Incidence: 5 - 20/100.000 persons per year
- Often associated with Tinnitus and a feeling of increased pressure, vertigo less commonly
- 20% of cases, a causal factor can be identified; In the remaining 80%, no clear cause can be found.

Etio-pathogenesis

- **Vascular:** any thrombosis or embolus of labyrinthine artery (terminal artery) would lead to a profound deafness with a poor prognosis
- **Viral:** mumps etc
- **Round window rupture:** trauma to the inner ear, heavy weight lifting, intracranial pressure rise
- **Auto-immune disease:**



The structure of the Ear.

Etio-pathogenesis

- Irrespective of the source of damage (noise, viruses, ototoxic substances and hypoxia.), the stria vascularis and the cells of the organ of corti in the inner ear react uniformly
- In the cochlea histological findings are
 - swelling and structural damage of the dendrites
 - alterations of mitochondria and the cell-structure,
 - separation of hair-cells from tectorial membrane
 - oedema of the endothelium
 - oedematous closure of functional endarteries with blocking of the microcirculation.

Etio-pathogenesis

- Prognostically negative factors are:
 - Vertigo
 - profound deafness (all frequencies)
 - therapeutic delay of more than 10-14 days
 - increased blood viscosity
 - hypertension

Natural Course of ASNHL

- Information on spontaneous remission rates differs greatly in the references, i.e. between:
 - 25-68% for spontaneous full remissions
 - 47-89% for spontaneous partial remissions.
 - 65% of polypragmatically treated patients :hearing improvement of 19 +/- 4 dB.
- From a statistical view, 35% and 39% of patients experienced no success with nonsteroidal drugs or placebo, respectively. These patients can still be helped with HBO therapy.

Therapy of inner ear disturbances

- Haemodilution (NaCl, Haes, Dextrane)
- Vasodilative” (Naftidrofuryl, Pentoxifylline, Flunarizine, Ginkgo biloba, Cinnarizine, Nicotinamide, Piracetam etc.)
- Prednisolone
- Vitamines
- Stellate Ganglion block
- Hyperbaric Oxygen (HBO₂)

Case Report - # 1

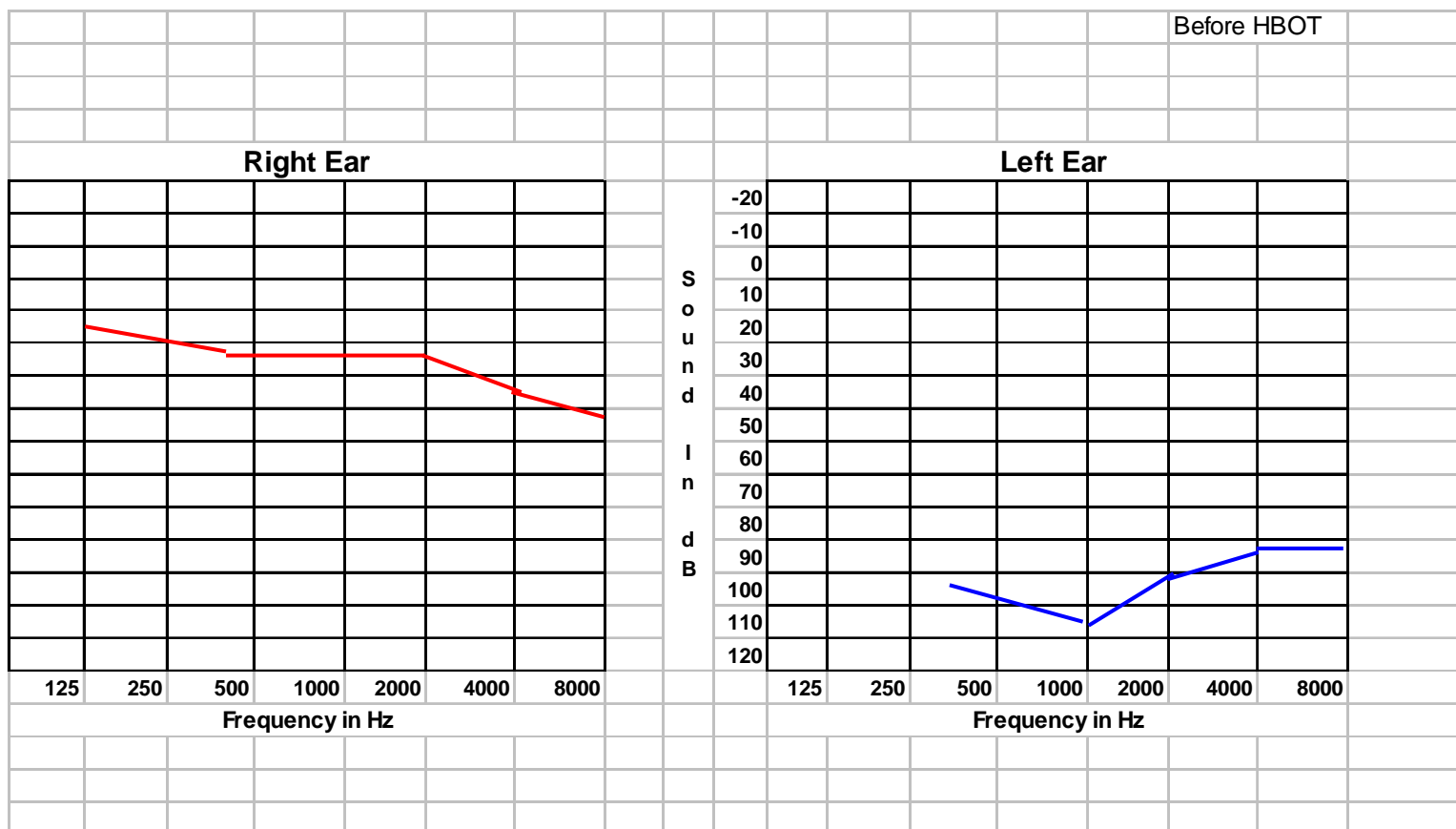
- A 40 years old healthy male
- **Complaints**
- C/o ringing in the left ear associated with decreasing hearing for past one week
- **History**
- H/o visiting a high altitude place following which developed complaints
- No H/o –
 - Upper respiratory infection
 - Viral infection
 - Ear infection or trauma
 - Hypertension
 - Diabetes
 - High grade fever
 - Drug reactions
 - Exposure to loud noises

Clinical Examination & Investigation

- Vitals normal
- General Examination : normal
- Chest, CVS, CNS & abdomen - clinically no abnormality detected
- Hematological findings normal
- 2-D Echocardiography normal
- Color Doppler findings normal

Audiometry

- Right ear – mild to moderate high frequency Sensorineural hearing loss
- Left ear – profound Sensorineural hearing loss

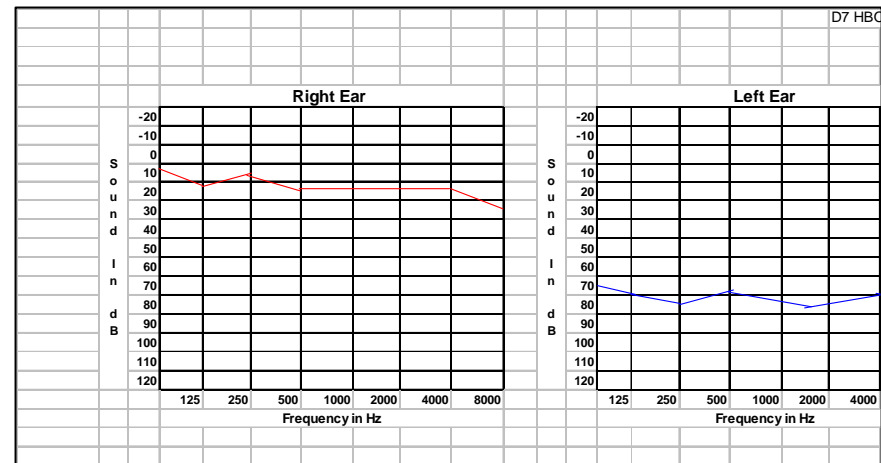


Treatment

- On presenting to Hyperbaric Department, Patient was on steroids regimen for almost one week without any improvement
- Course in Apollo – Patient started on
 - Hyperbaric Oxygen therapy
 - I/v Methyl Prednisolone
 - Oral Acyclovir
 - Nitrobid patch

Progress of treatment

- After 7 HBO sessions, repeat audiogram showed improvement
 - Right ear – from 40-55 dB to 20-35dB
 - Left ear – from 90-110 dB to 75-90dB
- Pt. continued with
 - Vit E 400 mg OD
 - Acyclovir 400 mg 5 times a day
 - Loprin 75 mg OD
 - Hyperbaric oxygen therapy



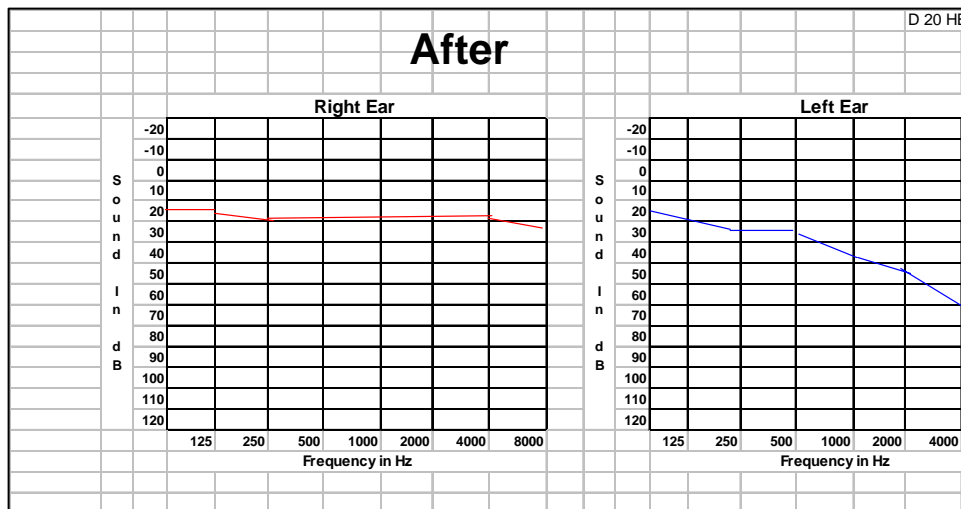
Progress of treatment

- After 20 HBO sessions, a repeat audiogram showed
 - Right ear – all frequencies in 20 dB range
 - Left ear – range 20-70 dB

Before



After



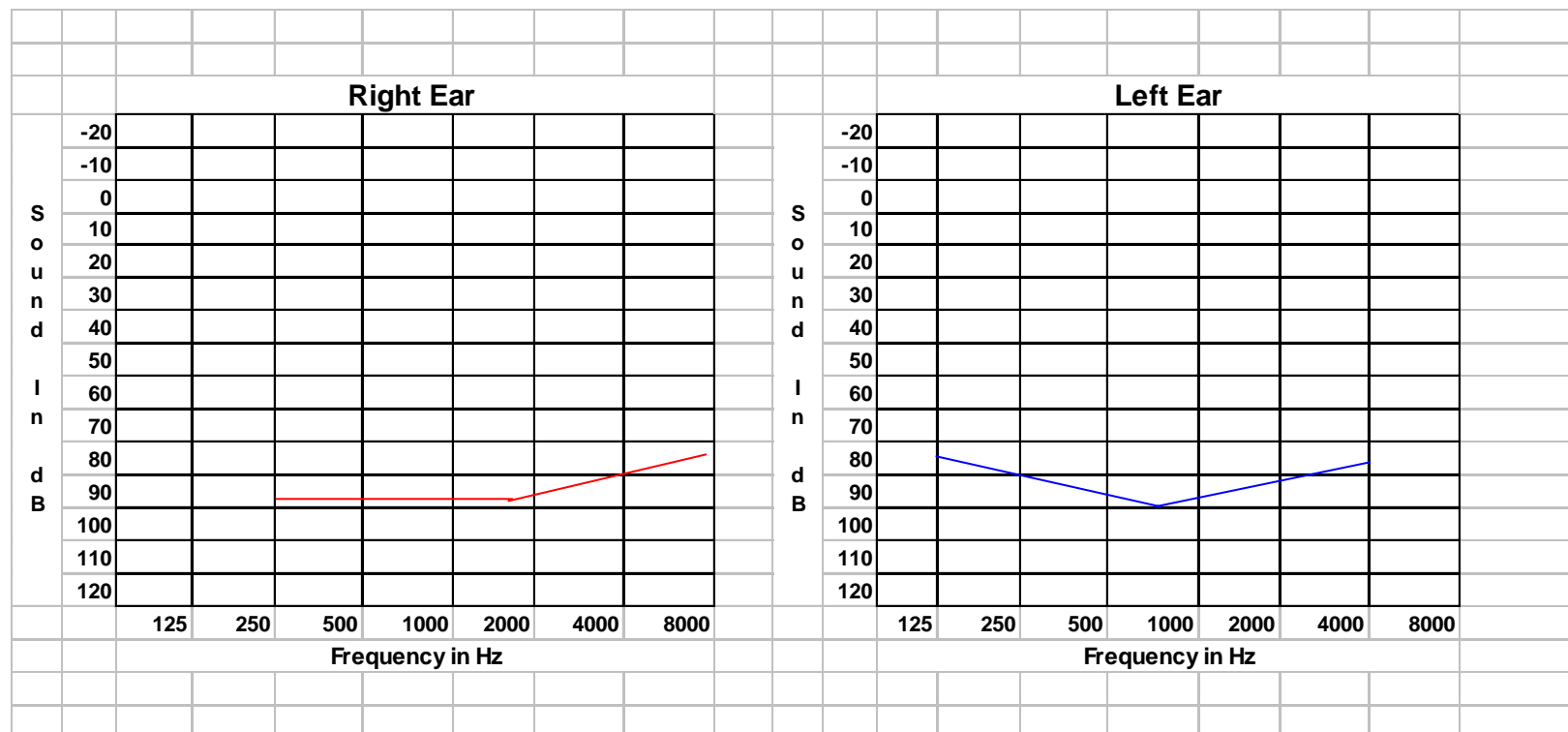
Case History # 2

- 26 years old male, household help, had already consulted many ENT specialists
- Presented with C/o
 - Sudden hearing loss associated Giddiness & vomiting with in both ears **since 14 days**
- H/o fever 14 days back
 - Dengue serotype +ve
 - Received treatment
 - At time of presentation platelet Count was 1.2 lakhs

Clinical History, Examination & investigations contd.

- No H/o Diabetes, Hypertension
- On examination:
 - Vitals normal
 - Chest, CVS, CNS, abdomen clinically normal
 - Audiometry – severe to profound hearing loss both ears

Clinical History, Examination & investigations contd.



Before treatment: Bilateral Severe SN Hearing Loss

Treatment

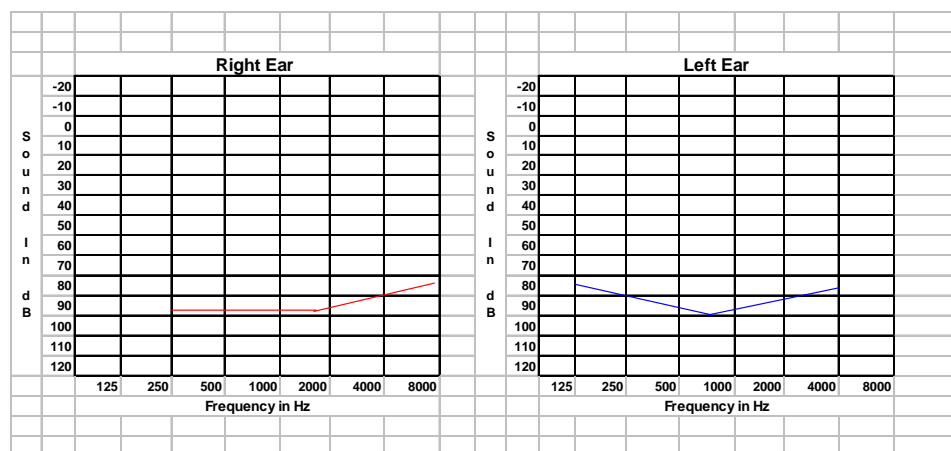
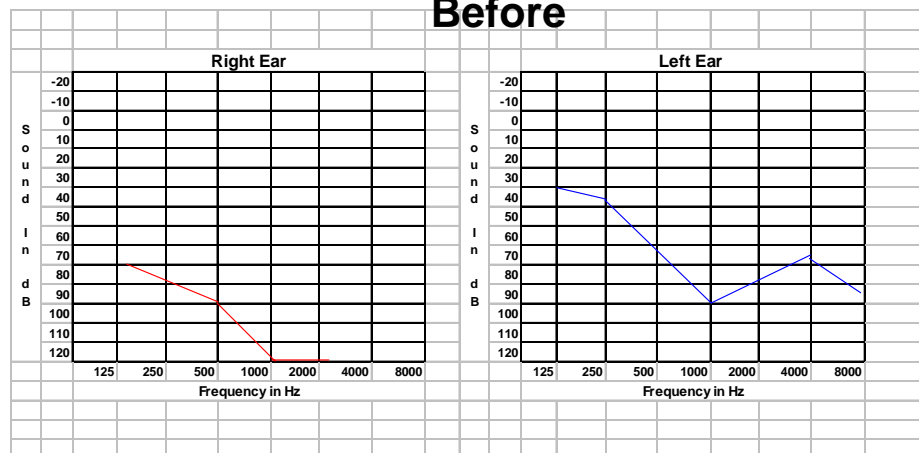
- Before hyperbaric treatment, patient had taken
 - Steroids
 - Acyclovir
 - Polyneurobion
 - Tab Vertin
 - No significant improvement
- Started with
 - Hyperbaric oxygen therapy
 - Wyselon 20 mg BD
 - Ginkocer 1TDS
 - Rejuneuron 1 BD

Progress of treatment

- After 10 Hyperbaric sessions
 - Patient showed symptomatic improvement and was able to hear some frequencies
 - On Audiometry
 - Right ear
 - before HBOT :all frequencies 80-90dB;
 - after HBOT – 80 –110 dB
 - Left ear
 - before HBOT – 80 –90 Db
 - after HBOT -
 - Lower frequency 30-40 dB
 - Middle frequency – 90 dB
 - Higher frequency – 70 – 80 dB

Progress of treatment

Before

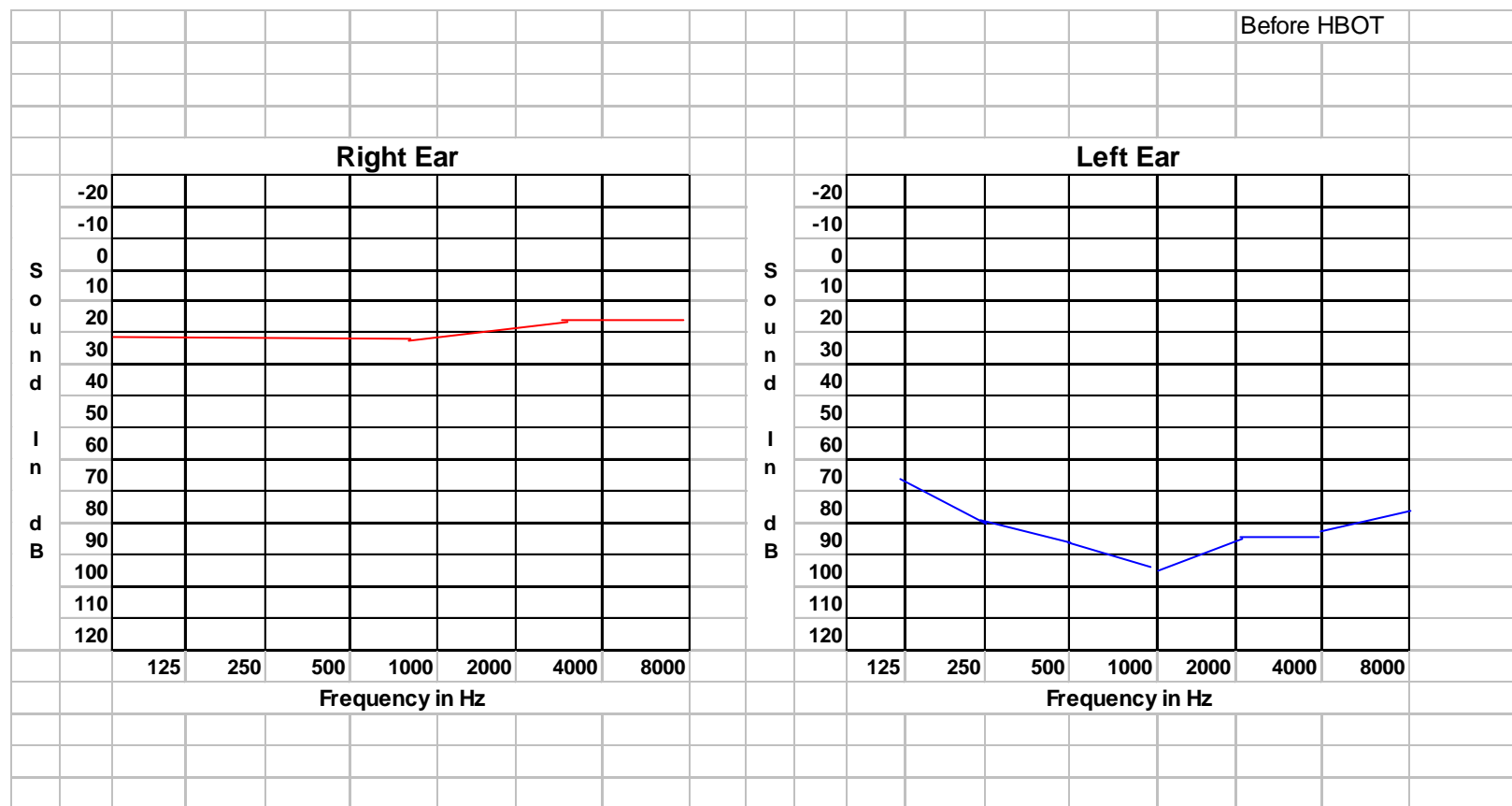


After 10 days treatment : Functional hearing

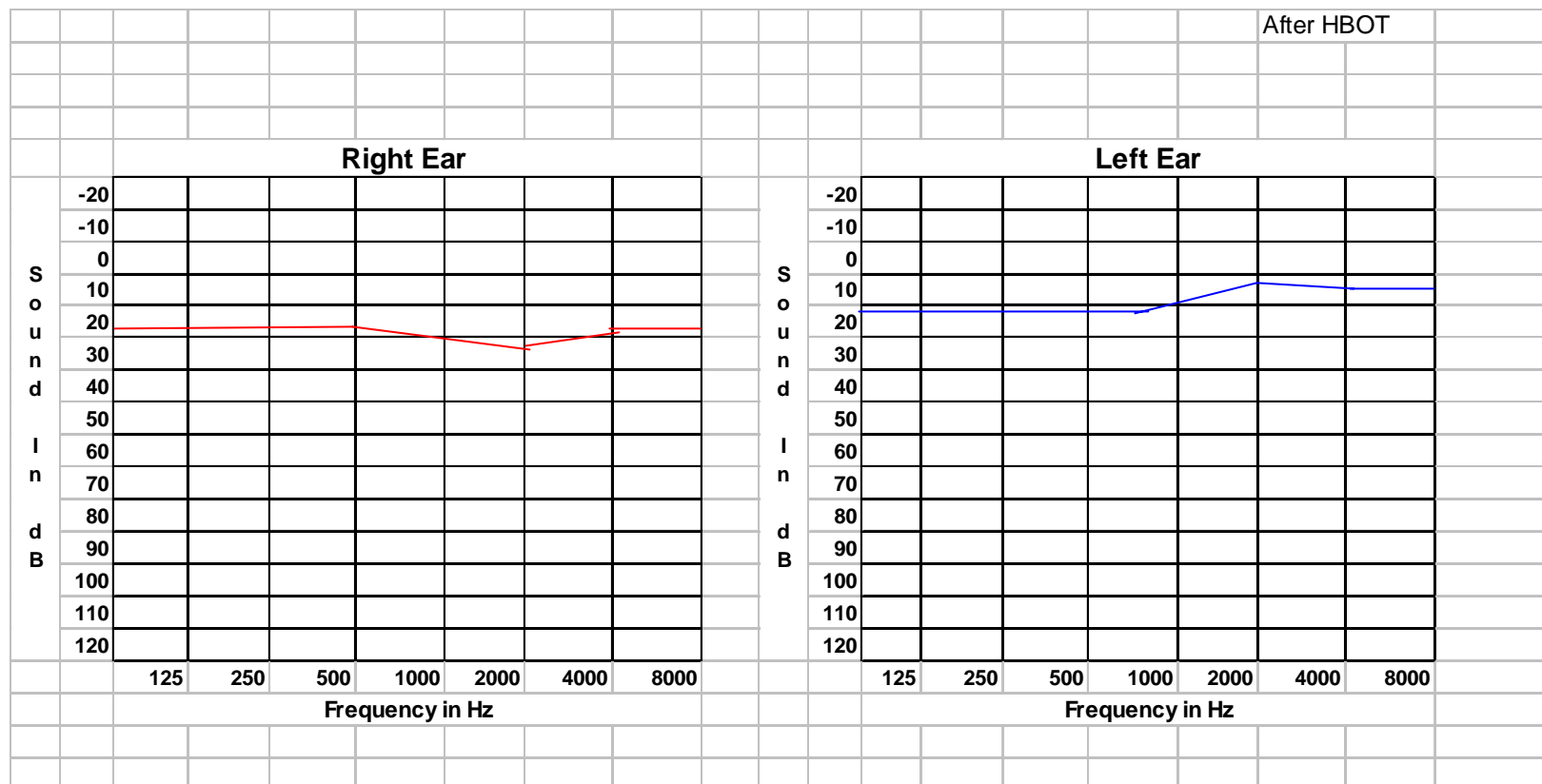
Progress of treatment

- Patient continued with HBOT for another 5 sessions and showed
 - Good progressive improvement
 - Functional hearing returned(Repeat audiogram not available with us)

Before treatment



After treatment



Apollo Experience

- No of Patients Treated : 52 (since 2000 June)
- Duration of ASNHL : 1 day to 3 months
- Results :
 - More than 70 % showed recovery except
 - Post Mumps
 - Drug Induced
- Future plans :
- **The Apollo HIED Study (The Apollo Hyperbaric Oxygen in Inner Ear Disorders Study**

Role Of Hyperbaric Oxygen

- **Rationale for HBOT in Sudden Deafness**
- HBO increases the pO₂ in the inner ear (Lamm et al).
 - The experimental evidence for this has been provided by Lamm et al (1988). The insertion of oxygen-sensitive microelectrodes into the inner ears of guinea pigs led to a drop of pO₂ in the scala tympani. The animals were placed in the hyperbaric chamber and after it was flooded with oxygen at normal pressure, pO₂ was noted to increase by 204%; when pressure was raised to 1.6 bar, pO₂ increased by 563% as compared with the original value. The increased oxygen supply corrects the hypoxia.
- HBO improves hemorrheology (Mathieu et al 1984) and contributes to improved microcirculation.
 - HBO not only lowers the hematocrit and whole blood viscosity, it also improves the erythrocyte elasticity (Pilgramm et al 1988).

Role Of Hyperbaric Oxygen

- During HBOT, amount of oxygen that is physically dissolved in plasma increases significantly
- Leads to an improvement of oxygen distribution throughout the tissues
- The acoustic ciliate cells and the peripheral fibers of the acoustic nerve receive not only direct oxygenation via the bloodstream, but supplemental oxygenation through the perilymph and cortilymph
- HBOT also effects cell metabolism and the $[Na^{sup.+}]$ $[K^{sup.+}]$ pump & leads to a restoration of the ionic balance and the electrophysiological functions of the cochlea
- HBOT reduces hematocrit and blood viscosity, and this can have a rheologic effect in the cochlear region

Role Of Hyperbaric Oxygen

- **What are the conditions that is not likely to work :**
- The possibilities of recovery are much less in conditions such as
 - Post viral hearing loss
 - drug induced loss
 - mumps
 - central nervous system cause of hearing loss.

Indications for HBO2 in the field of ENT

Tinnitus

Related to acoustic trauma, head injury, sudden deafness, M. Ménière

Hearing Loss

Related to sudden deafness, M. Ménière, ototoxic damage, acoustic trauma, trauma, infection

Deafness

Related to sudden deafness, M. Ménière, ototoxic damage, acoustic trauma, contusio labyrinthii, barotrauma, zoster oticus, postoperative

Vertigo

Related to acute functional loss of peripher vestibular organ, irritation of labyrinth, contusio labyrinthii, M. Ménière, sudden deafness

Otitis externa maligna

Guidelines of the German Soc. ENT-Diseases, Head and Neck Surgery

Effect of hyperbaric oxygen therapy in comparison to conventional or placebo therapy or no treatment in idiopathic sudden hearing loss, acoustic trauma, noise-induced hearing loss and tinnitus. A literature survey.

Lamm K, Lamm H, Arnold W

Department of Otolaryngology, Head and Neck Surgery, Klinikum rechts der Isar, Technical University of Munich, Germany.

- 50 studies :4, 109 patients suffering from idiopathic sudden hearing loss, acoustic trauma or noise-induced hearing loss and/or tinnitus,
- HBO therapy was administered as a secondary therapy, **i.e. following unsuccessful conventional therapy.**

Results :

- **If the onset of affliction was more than 2 weeks but no longer than 6 weeks,**
 - one half of the cases showed a marked hearing gain (in at least 3 frequencies of more than 20 dB),
 - one-third showed a moderate improvement (10-20 dB) and
 - 13% showed no hearing improvement at all (fig. 2).
 - 4% no longer experienced tinnitus,
 - 81.3% observed an intensity decrease and
 - 1.2% an intensity increase of their tinnitus condition. 13.5% remained unchanged (fig. 2).

Effect of hyperbaric oxygen therapy in comparison to conventional or placebo therapy or no treatment in idiopathic sudden hearing loss, acoustic trauma, noise-induced hearing loss and tinnitus. A literature survey.

Lamm K, Lamm H, Arnold W

Department of Otolaryngology, Head and Neck Surgery, Klinikum rechts der Isar, Technical University of Munich, Germany.

Results : Contd..

- **If the onset of affliction was longer than 3 months up to several years,**
 - no hearing improvement can be expected in the majority of patients (fig. 3); however,
 - one third of the cases reported an intensity decrease of tinnitus,
 - 60-62% reported no change
 - 4-7% noticed a temporary intensity increase

In conclusion:

- It may be deduced that HBO therapy is recommended and warranted in those patients with idiopathic sudden deafness, acoustic trauma or noise-induced hearing loss **within 3 months after onset of disorder.**

Other references

- *Adv Otorhinolaryngol* 1998;54:100-9
- **Hyperbaric oxygen therapy for sudden deafness.**
Nakashima T, Fukuta S, Yanagita N
Department of Otorhinolaryngology, Nagoya University School of Medicine, Japan
- *Lin Chuang Erh Pi Yen Hou Ko Tsa Chih* 1997 Sep;11(9):399-401
- **The dosage of hyperbaric oxygen therapy in patients with sudden hearing loss].**
Article in Chinese
Lu X, Zhang S Department of Otolaryngology, People's Hospital, Liaocheng Prefecture, Shandong Province
- 33 patients / Free radical metabolism substances in different stages of hyperbaric oxygen (HBO) therapy
- HBO should not be carried out for more than 20 days.

Other references

- *Rev Laryngol Otol Rhinol (Bord)* 1993;114(1):53-8
- **Sudden deafness: a randomized comparative study of 2 administration modalities of hyperbaric oxygen therapy combined with naftidrofuryl.**
[Article in French]
Dauman R, Poisot D, Cros AM, Zennaro O, Bertrand B, Duclos JY, Esteben D, Milacic M, Boudey C, Bebear JP C.H.U. Bordeaux, Hopital Pellegrin, Service ORL, France
- This study compares the effects of hyperbaric oxygen therapy in two groups of patients; according to their order in randomization the subjects were treated either at a rate of 1 session or 2 sessions per day.
- The rate of 2 sessions of hyperbaric oxygen therapy per day has obvious advantages in view of health policy, but it requires the hospitalization of the patient and should be restricted to the younger subjects.

Other references

Antioxidants and hyperbaric oxygenation in the treatment of sensorineural hearing loss in children

- Article in Russian
- Muminov AI, Khatamov ZhA, Masharipov RR.
- Efficiency of hyperbaric oxygenation (HBO) in combination with antioxidants was studied in 36 children aged 1-14 years with neurosensory hypoacusis vs standard treatment. A course of HBO consisted of 10 sessions (1.4 atm) for 40 min. The response was registered in 72.2% patients. It manifested in improvement of sound perception at 5-25 dB. The highest effectiveness was seen in acute neurosensory hypoacusis.
- **Thus, HBO in combination with antioxidants is recommended in combined treatment of neurosensory hypoacusis in children.**

Other references

Does the addition of hyperbaric oxygen therapy to the conventional treatment modalities influence the outcome of sudden deafness?

Otolaryngology - Head And Neck Surgery February 2002 •

Ismet Aslan, Cagaty Oysu, Bayram Veyseller, Nermin Baserer. **Istanbul, Turkey**

- Retrospective review of 50 cases of SD treated at a tertiary university hospital. Twenty-five patients (group 1) were treated with betahistine hydrochloride, prednisone, and daily stellate ganglion block.
- A second group (group 2) of 25 patients received the same basic treatment with the addition of HBO therapy.

Conclusions: The addition of HBO therapy to the conventional treatment significantly improves the outcome of SD, especially in patients younger than 50 years. Additional HBO therapy provides limited benefit in patients older than 50 years and no benefit in patients older than 60 years.

Conclusion

**Does Hyperbaric Oxygen Have a Role in
Acute Hearing Loss , Acoustic Trauma ,
noise induced Hearing loss
& Tinnitus ?**

Yes

- When should Hyperbaric Oxygen Therapy be prescribed?

Best results within 3 months of onset .

- How many therapies should be given.

Minimum 10 therapies

***Maximum Twenty therapies with Hyperbaric Oxygen
(each therapy lasts 1 1/2 hours) .***

An Invitation

To visit Delhi & Apollo Hospital



National : academic initiatives

Hyperbaric Society of India

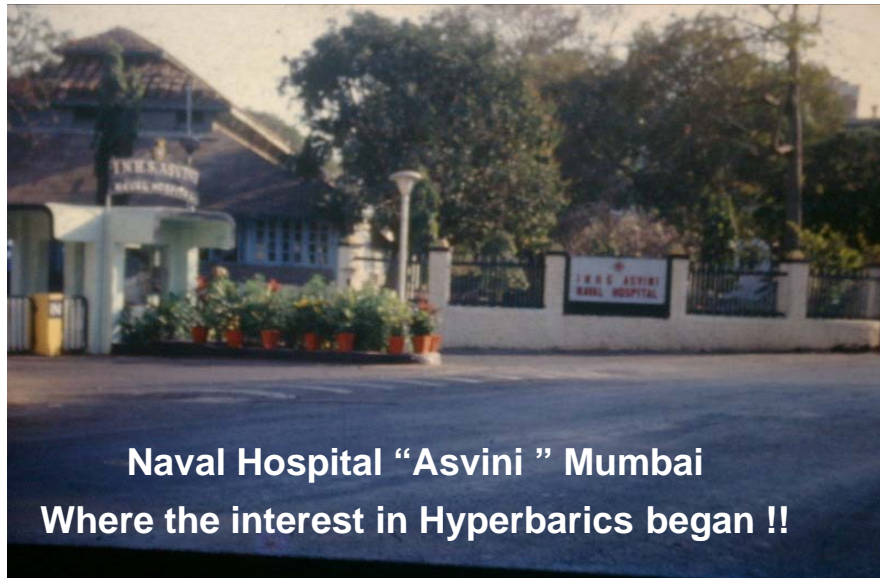
www.hyperbaricindia.com



- Training
- New Centres
- Join existing centres

Acknowledgements

Spontaneous and consistent support of the International Hyperbaric Community without whose help this center may not have come up



Thank you

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