

CLINICAL EXPERIENCE WITH A SINGLE PATIENT HYPERBARIC CHAMBER

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This paper summarizes practical experiences with the first 100 cases treated in a single patient Hyperbaric Chamber at Prince Henry's Hospital, Melbourne.

The Unit, generously donated by the William Duchland Foundation in 1960, is a Vickers RHS/3 Radiotherapy System which utilizes a high flow oxygen supply with no recirculation.

The chamber is 7 feet in length with an internal diameter of two feet. The walls are double layered methacrylate with an interface of air. Oxygen flow rates vary between 250 and 400 litres per minute.

Advantages of this single Unit are:

1. Relatively Cheap Installation. The Unit is located in a small room at the far end of a general surgical ward.
2. Low running costs. Oxygen is taken from the Hospital's Liquid Oxygen supply. At the current rate of \$12.30 for 100 cubic metres, 2 hours of therapy costs no more than \$4.30.
3. The whole body is visible and immersed with oxygen. The patient does not have to endure the discomfort of a mask and it is ensured that the highest concentration of oxygen is inhaled at all times.
4. Minimal risks to attendants. There are no problems with medical attendants enduring the effects of pressure or nitrogen within the Unit.

Patient Comfort

Practical problems of patient therapy involve - apprehension, boredom and sheer claustrophobia. Light sedation is often administered for the first treatment but simply psychology of explanation and reassurance is more effective. Boredom is relieved by a radio transmitted through the chamber intercom circuit and claustrophobia is a more difficult problem involving tact and strong persuasive powers.

COMPLICATIONS

1. Effects on the Ears

Ear discomfort is reduced by slow pressurisation and Valsalva manouvers performed by the patient. No myringotomies are undertaken and severe aural dysbarism is relieved by suddenly dropping the chamber pressure 1 p.s.i. followed by slow re-pressurisation.

2. Convulsions

Two convulsions due to oxygen toxicity are reported in our series. Both occurred at the unnecessarily pressure of 3 Atmospheres Absolute. It is now our practice to treat at 2.5 A.T.A. and no problems have occurred at this pressure.

3. Lung complications

Pulmonary effects from high oxygen tensions have not been evident but it has recently been decided to use 5 minute air breaks every 25 minutes on oxygen, particularly during prolonged therapy.

Deep breathing is encouraged, following removal of the patient to the normal air environment. This practice tends to prevent the onset of atelectasis.

4. Risk of Fire

Of all the possible problems, fire in an oxygen environment is the single item that would have tragic consequences. The late 1960's were beset by fires in space-craft, fires in research units and fires in clinical Hyperbaric Units. We were obsessional in following these precautions in eliminating all possible sources of ignition:-

1. No electrical circuits
2. No heating
3. No static

We therefore increased humidity and did not allow the patient to wear any synthetic clothing whatsoever. Pure cotton theatre garments were the usual apparel.

PATIENTS TREATED

1. Ischaemic Limb Disease	44
2. Specific Wound Infection	22
3. Gas Gangrene	14
4. Joint Bends	6
5. Carbon Monoxide Poisoning	4
6. Air Embolism	1
7. Miscellaneous	<u>9</u>
	<u>100</u>

In our first one hundred cases we treated 44 ischaemic conditions, 22 specific wound infections, 14 cases of true gas gangrene, and 6 cases of joint bends, 4 cases of carbon monoxide poisoning with 1 of air embolism concluding the main series.

VASCULAR CONDITIONS

1. Athero-sclerosis	15
2. Vasospastic	12
3. Post Operative Ischaemia	12
4. Occlusive	<u>5</u>
	<u>44</u>

The high number of ischaemic limbs treated resulted from the activities and interests of the vascular surgeons at our hospital. The therapy was of dubious value in chronic ischaemic limb disease but often of diagnostic help in delineating an ischaemic boundary. Improved results were seen when combining the oxygen with oral α blocking agents.

Surprisingly several patients with vasospastic disease involving the fingers did particularly well. Sudden dramatic relief of the spasm occurred either during or several hours after therapy.

A patient with Raynauds disease showed considerable improvement following one treatment session.

Wound Infections - Gas Gangrene

The 22 specific wound infection were mainly post operative; where clostridial welchii had been isolated or gas gangrene suspected. These progressed well and none went on to develop a toxic gas gangrene picture. It is of course impossible to ascertain whether oxygen any help since broad spectrum anti-biotic cover was administered in each patient.

Of all conditions treated none has been so satisfying, curative and life saving as the application of hyperbaric oxygen in gas gangrene. We totally agree with this statement obtained from a surgical colleague at the Royal Melbourne Hospital - "The treatment of clostridial gas gangrene with Hyperbaric Oxygen therapy has been a giant a step forward in the treatment of this disease as was penicillin in the treatment of pneumonia".

All 14 patients in our series were toxic and exhibited clinical evidence of gas, crepitus, and wound discolouration. Seven had gangrene of a below knee amputation stump following surgery for peripheral vascular disease; 2 of these were diabetics. Self contamination of the stump from the rectum was the likely source of infection.

Six patients developed gas gangrene of the limbs following trauma; compound fractures of the leg after motor cycle accidents were a common cause. Gas gangrene of the abdominal wall occurred in two patients with colostomies.

All cases were treated at the following regime:-

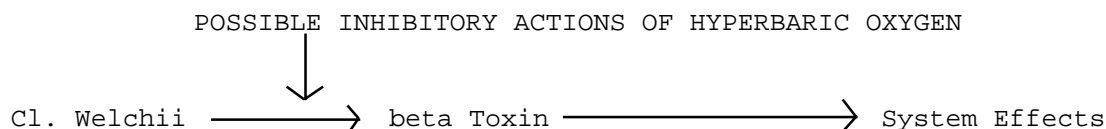
1. Oxygen - at 2.5 ATA - 2 sessions daily, therapy continuing for up to 5 days.
2. Penicillin - approximately 24 Mega Units per day.
3. Surgical Debridement and Suture Removal - when necessary.

There were three deaths in the series, one followed severe abdominal trauma, another died with extensive secondary carcinoma and an 84 year old died five hours after surgical debridement.

It was interesting to observe that patients who were confused and apathetic before treatment became alert and co-operative in the high pressure oxygen environment.

Improvement in the system condition was often apparent following the first treatment.

There is no question that we totally agree with other workers in the field that Hyperbaric Oxygen in life and limb saving - an essential tool in the treatment of gas gangrene. Furthermore it may reduce the need for extensive mutilating surgery. In theory it converts a favourable environment for the anaerobes into an unfavourable one. Ischaemic tissues become oxygenated, toxin production is inhibited and penicillin activity is aided.



COMPLICATIONS OF DIVING

An interesting group of patients treated were divers with joint pains. Four of the six were professional Abalone Divers. This group presented with severe shoulder pain associated with some restriction of movement. No other clinical signs were present.

Recompression therapy following Table 6A or 6B resulted in a full cure in all cases. We now feel it is desirable to intersperse 5 minute air breaks every 20 minutes, particularly when using the longer recompression table, ie. Table 6B.

Following treatment the patients are returned to the ward on oxygen. This practice tends to decrease the incidence of "niggles" in the next few days which is due to the nitrogen re-expanding the original bubble. We allow them home the following day, and they are told not to dive for at least one week - preferably two.

CARBON MONOXIDE POISONING

Only 4 cases of carbon monoxide poisoning have been treated. Our low figures compared with those from Sydney are likely to be due to the natural gas supply in Melbourne. Carbon monoxide however, is not a fashionable form of poisoning today.

All our cases were suicidal rather than accidental and all used a pipe from the car exhaust as a source of inhalation. Furthermore they had consumed prior to the attempt either sedatives, tranquillisers or alcohol. This common practice tends to confuse the overall picture. The experience gained was that Hyperbaric Oxygen was useful particularly in the later stages. It is useful for practical purpose to be aware of the half life of carbon monoxide in air and oxygen (Reference 1)

1. Breathing air - half life is 4 hours
2. Breathing 100% O2 at 1 ATA - 49 minutes
3. Breathing 100% O2 at 2.5 ATA - 9 minutes

Associated therapy involves the administration of steroids and diuretics for cerebral oedema and strict airway maintenance at all times. Psychiatric referral is invariably necessary.

In conclusion it appears that the indications for Hyperbaric Oxygen are clearly outlined:-

1. Gas Gangrene
2. Carbon monoxide poisoning
3. Radiotherapy of specific tumours
4. Air embolism
5. Decompression sickness
6. Surface infection, burns, ulcers
7. Selective ischaemic conditions

The Unit is available for use 24 hours per day and priority emergencies include air embolism, carbon monoxide poisoning, gas gangrene and joint Bends.

Experience has shown *Whom to Treat, How to Treat and When to Treat.*

The Unit is regarded as an important therapeutic facility which although not fully stressed on a day to day basis, is available when required. Since the completion of this paper one further case of gas gangrene has been treated. This patient received

a gun shot wound of the abdomen and subsequently died following surgery of the bowel and abdominal wall. He remained intubated while in the chamber and was ventilated with a simple fluid logic ventilator. The ECG was monitored with praecordial leads connected to an external cardiac monitor through the special sockets present in the chamber door.

It is important to inflate the cuff of the endotracheal tube with water and not air, since pressurisation compresses the cuff and prevents a proper seal.

A further patient with gas gangrene of the abdominal wall following abdomino-perineal resection of the rectum has just completed five days of oxygen, antibiotics and surgical debridement, including the removal of left rectus muscle.

He appears to have made a satisfactory recovery and will not require further hyperbaric oxygen therapy.

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References

1. Unsworth IP (1974) Acute Carbon Monoxide Poisoning, Anaesth. and Intensive Care, 4:329.

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Some people are abnormally sensitive to decompression sickness. One New Zealand diver is so liable that he must limit himself to 20 feet depth maximum.

Chest pain after a dive may indicate mediastinal emphysema or myocardial ischaemia.

Many divers are too buoyant to maintain a 10 foot or 20 foot decompression stop depth. Sport divers should avoid dives requiring decompression stops.

Cold gives little warning of the onset of Hypothermia. Abnormal behaviour (forgetfulness) may occur. 70% of the human body is within 2.5 cms of the surface. Activity increases heat loss. Danger period continues after the victim has been removed from the water. Heat loss occurs even in "warm" water. Severe but reversible hypothermia may produce a deathlike appearance and therapy be wrongly though useless.

In-water Oxygen therapy can be limited to 10 metres by so limiting the length of the gas supply hose.

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