SPUMS SCIENTIFIC MEETING 1986

CHAMBERS AND CHAMBER FIRES

Andrew Pilmanis

CHAMBERS

Hyperbaric therapy has a history of over 300 years. Hyperbaric oxygen (HBO) therapy in the United States is now respectable. This was not always so. It does have a very bad history of exploitation with no sound basis. Back before the turn of the century in Europe and later in the United States various chambers were operated for all sorts of indications. Dr Orval Cunningham[1] got into the business. He started treating anything, any disease that walked in off the street, and became a rather wealthy man with his 26.6 m (88 foot) long chamber. He decided to go on to bigger and better things and built the world's largest chamber. It was circular, seven stories high, with seventy two rooms. It was a rather posh hotel inside. Unfortunately for Orval the American Medical Association by that time had had enough of his practice and took his licence away and that ended his career in hyperbaric medicine and rightly so. The chamber after that became a Catholic Girl's School, and then at the start of the Second World War it was cut up for scrap.

In the 1950s and 1960s there were other questionable practices in hyperbaric medicine. All of this has left the medical community in general with a bad taste in its mouth when you mention hyperbaric oxygen therapy, even to this day. However in the last 10 years the hyperbaric medicine field has finally come on a solid footing. There is sound physiological data available for the diseases being treated. There are still a few individuals around treating executive high blood pressure during the lunch hour, baldness and a variety of other things for money. But in general the Undersea Medical Society can be commended for putting together a decent basis. The chambers used vary tremendously in size and shape.

Multiplace chambers

Large multiplace, multi lock chambers in hospitals are necessary for the fullest application of HBO to sick patients. There is a very large one in Baltimore, which measures about 15 m (50 feet) long, and 3 m (10 feet) in diameter. It is a very active unit and very good operation. It is an excellent example of the large hospital based facilities.

One of the newest ones is in Northbridge, just north of Los Angeles, it is a L-shaped chamber, with what they call the acute block then a sphere and then the long chronic unit. They are apparently treating an average of 14 patients a day. It is a very active unit treating primarily slow wound healing, from a variety of causes, gas gangrene carbon monoxide poisoning and the occasional diving accident. The Northbridge chamber is automated. One operator runs the whole thing. They have been in operation for a year and are doing very well financially. They operate with a staff of two physicians, five nurses and one technical person. What really increased their number of patients was an incident about a mile from the chamber at a Catholic Girls School. It had a dormitory where a heater malfunctioned during the night and the whole dormitory heating system was flooded with carbon monoxide. They treated 137 nuns and young students in one week in their chambers quite successfully.

Diving accidents are a losing proposition. Firstly, the diver seldom pays, that is well established. Secondly, treatment table takes up six hours or more whereas HBO therapy is an hour and a half. Thirdly, you can only put one diver in the chamber while in multiplace chambers you can put 10 people in at a time. Treating divers has PR value but on a financial basis it is not very good.

The typical field, military or commercial diving chamber is 1.3 m (54 inches) in diameter, with a double lock and manual control. It is the most common type of chamber around the world. It is quite adequate. One of the bad things about these chambers is the circular hatches. It is difficult to get patients in and out, but one can live with that. Some people have a steel chute down which the patient is slid.

One of the smallest double locked multi-placed chambers manufactured is 1.05 m (42 inches) in diameter. Again it is adequate and is quite affordable. It is used in the commercial diving industry fairly extensively. As an example of how successful it can be, Dr David Youngblood treated a commercial diver with cerebral arterial gas embolism (CAGE) in the Gulf of Mexico, in one. He, the tender and patient were inside for 7 days. It was an heroic effort but it can be done.

Over 200 chambers are listed as active in the United States. The vast majority sit in a back room and are not very active. However there are probably fewer than 10 active facilities with multiplace large hospital based chambers in the United States. It is not a large

field. My criteria is that they are on a sound basis, that they are successful, and that they are doing good work.

Two person chambers

There is a push in various places for two-man chambers, the idea being for a tender to be with the patient during transfer. Carl Edmonds tell the story of using an old single man surface decompression chamber for "victim" and attendant which meant that neither could move or even be comfortable. I question the value of the tender chamber which was originally designed for a single fit diver to do surface decompression in and which is not fitted for transfer under pressure to a larger chamber. In a Drager Duocom the patient lies on a stretcher and the tender sits up with the patient's head between his legs. When pressurized it can be transported to a large chamber and mated onto it. I have not seen one used but I understand that they are used in Australia. And according to David Elliott the Swiss use it for retrieval of divers who have got bent in their lakes. I think it has the same problem that the tender really is very limited in what he can do.

The US Navy has its own version of a two-man chamber. It is a canvas chamber with the world's largest zipper and pressurized with scuba bottles. It delivers oxygen to the sufferer. The idea was to roll it up in a bag and store it on a ship until it was needed. Then one could pressurize the patient in it and transport him to a large chamber and take it in. Although it has a burst pressure of something like 257 metres of seawater (msw) (850 feet), unfortunately the US Navy regulations have sections on certifying aluminium chambers and steel chambers but had no section on canvas chambers. That of course ended the like of this chamber. If one cannot find it in the book, no one can certify it. I believe it still sits in Florida although I am not sure what has happened to it.

I have talked to Bob Sands about his design2 and it is interesting. It solves the problem of access to the patient in a two-man chamber.

I can see no role for two man chambers in treatment as assessment of the patient is virtually impossible. They may have a place in the transport of patients to a large chamber provided that the patient can be transferred into the large chamber while still pressurized.

Monoplace chambers

Monoplace acrylic chambers are very common in the United States. Just about every city hospital has one or more of these. They are pressurized not with air but with 100% oxygen. They are rated at the most to 18msw (60 feet). They are used for HBO therapy quite successfully and adequately.

I object to their use for diving accidents for a number of reasons, although there are a number of physicians in the United States who do use these for the treatment of diving accidents. One cannot run a commonly accepted treatment table in them because one cannot deliver air. So the most one can give is one and a half hours of 100% oxygen and then one has to take them out. Without air breaks, one would have to run a very short table. The adequacy of the one and a half hour table on air embolism and decompression sickness has never been proven. One cannot got to 6 ATA which is the standard of the worldwide treatment for air embolism. I know of two cases treated in monoplace chambers, one was a steel one and one was an acrylic one, where unknown to the persons outside, the patient developed an pneumo-thorax. When the pressure was reduced of course the pneumo-thorax expanded. In both cases the patient died by the time they were back to atmospheric pressure. There was nothing the operators could have done about it even if they knew what was happening. This applies if the patient has any problems. With carbon monoxide poisoning one simply depressurizes and brings the patient out and solves the problem. But with air embolism and decompression sickness if one does that the bubbles that have not yet dissolved re-expand and one creates a continuing problem popping them up and down. And finally one cannot do repeated neurological examination in them. Our whole management is based on frequent neurological examination to assess progress.

Comment

Dr FM Davis

At Christchurch we get quite a number of cases transferred down to us by chopper from the Wellington area which is at the bottom end of the North Island of New Zealand. Recently they have taken to putting one or two of the more severe ones into their monoplace chamber, and compressing them to three atmospheres on O_2 while they wait to arrange the chopper flight. In one particular instance I am certain that the exercise significantly worsened the lesions.

Do you have any comments on using hyperbaric oxygen followed by another decompression before transfer to a treatment facility?

Dr A Pilmanis

Did they bring him to the surface before transferring him to your chamber?

Dr FM Davis

Yes, he was decompressed and then flown to us.

Dr A Pilmanis

When did he worsen?

Dr FM Davis

It is not possible for me to be precise about that. All I know is that I could see from an administration note that at Wellington Hospital the patient was totally different then from the patient I received.

Dr A Pilmanis

I would first like to know whether that worsening occurred in that decompression from the HBO. Obviously if it did they had done an inadequate treatment. If one does not do the complete treatment procedure, our assumption is one has not eliminated the bubbles. If the patient is brought to the surface prematurely what is going to happen? Bubbles re-expand and if they are in the right (or wrong) place at the right (or wrong) time there is a worsening of his condition. That is another of my objections to monoplace chambers. Not just because of the transfer aspect but because if something happens, say the patient vomits and is aspirating, what are you going to do? You cannot practise hands on medicine through perspex. You have to decompress the chamber and when you do, if you have done an inadequate treatment the bubbles are going to re-expand and the patient's condition is going to worsen. That is the way I see it.

Dr Takashi Hattori, in the Monterey Peninsula area, has had a long, about 12 years, experience with a monoplace chamber when there was no double lock chamber in the San Francisco, Greater Bay area. With the serious cases he put them in the monoplace chamber. Then had them flown from the chamber to San Diego or Catalina. The monoplace chamber was taken into the bigger chamber which is a complicated exercise, and the patient was decanted under pressure. He practised this by necessity to avoid decompressing them before transport. Now he has a double lock chamber and he has thrown away his monoplace.

Dr FM Davis

I think this is a very important point because as you have pointed out there are a lot of monoplace chambers around. There are three to my knowledge in New Zealand. The tendency is that once there is an enthusiast or two in a particular area they start using the monoplace chamber. I am really quite concerned about that and I think this is a topic that should be aired.

Dr A Pilmanis

I have been accused of being somewhat, even almost, irrational about monoplace chambers so I am trying to stay calm here. I would say that, if one has to wait an hour and a half for a helicopter, it is better to give 100% oxygen by mask then recompress and decompress from a monoplace chamber. I am talking about true 100% oxygen because what one is trying to do is to exclude nitrogen, not give oxygen. I think that statement should be emphasized. If the mask does not fit properly one is not excluding nitrogen.

CHAMBER FIRES

Almost all chamber fires have been caused by extreme negligence. Recently, off Santa Barbara in Southern California, a diver on an oil rig was working on air at 85 msw (280 feet). He finished the job on a pipeline and came up covered in oil. They were using surface oxygen decompression, which is standard practice, that is they bring the diver to the surface and they have five minutes to get him into the chamber and pressurized to 12 msw (40 feet). They then decompress the diver on oxygen in the chamber. The diver had his helmet taken off and got into the chamber. A young student diver who was in his bathing suit spraying down equipment with WD40, which is a petroleum based product, and who was covered in the stuff, went in as tender. The diver was covered in oil. At 12 msw (40 feet) on oxygen the diver lit up a cigarette. In my definition that comes under extreme negligence. They both burned, they both lived. The young man in the bathing suit got the worst of it because he was exposed whereas the diver was still in his diving gear, except for his helmet. The diver had his ears burned off and his nose burned

off and so on but he was back in diving in three months whereas the young man will never dive or do much else. When the supervisor of the operation was asked, "Why did you let him do something like that?" he said, "There is nothing wrong with that, we do it all the time." At that point the person who asked the question turned around and laughed. There was no sense continuing the conversation. That is the type of extreme that chamber fires come from. That includes the US Navy but most of the chamber fires occur in the commercial diving industry.

One is working in a very dangerous environment in a chamber and to me it is essential to avoid taking known risks.

References

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DIVING ACCIDENT MANAGEMENT

THE CATALINA CHAMBER AND ITS CLIENTELE

Andrew Pilmanis

The Chamber

Our chamber at Catalina[1] is a 7.3 m (24 foot) long, 2.7 m (9 foot) diameter, rectangular door, double lock, 7.8 ATA (100 psi) chamber. It was donated by the Lockheed Corporation. It was brought over by a tug boat company free of charge which was very nice of them. They lifted it off and placed it on the railway and said goodbye. The thing weighs 22 tons and we had a great deal of fun in installing it. Getting it into the building was interesting. It is large. There are pros and cons to large chambers. My original reason for getting the chamber was research and size is a big plus. One can put a great deal of equipment and people and so forth inside a large chamber. We have had four simultaneous patients, 3 or 4 tenders inside in comfort. Whereas in a 1.3 m (54 inch) chamber one simply could not do that. We also do a tremendous amount of training. When one can put 10 or 11 people inside the chamber it saves a great deal of time.

We have a fire suppression system, which many chambers do not. I am a firm believer in such a system. Once a year we have what we laughingly call a chamber party. One of the exercises we do is we pressurize 4 or 5 people down to 50 msw (165 feet) and let them have a water fight and use the fire system. It does several things. It clears the pipes of any rust, or anything of that nature. It builds confidence in the crew because they have used the system. It proves the system works. And at 6 ATA, narcosis level, having some fire hoses going is a lot of fun.

The negative side of a large chamber is that it is in need of a great deal of machinery, machinery meaning large compressors, high pressure gas and so on. Compressor maintenance, size of compressors and so on, that is where the expense and time is. Our chamber interlock is approximately 28,000 lt (1,000 cubic feet) and to pressurize to 6 ATA takes a lot of gas. We put all the plumbing for the chamber together ourselves. We did not contract it out as we did not have the money. Being a physiologist I did not know the first thing about plumbing. However after a year of plumbing the chamber, I think I can plumb any chamber anywhere. It can be done, I cannot say inexpensively, but certainly for a lot less than what manufacturers quote.

The patient and staff

We are isolated. There is no hospital on the island. We treat all the local diving accidents. We do no hyperbaric oxygen therapy (HBO), although we have treated about 8 people with carbon monoxide poisoning off boats where the individuals were cold at night, left their gas stove alight and closed all the windows. In the morning they were found unconscious. They were right next to us and we did treat them but routinely we only treat diving accidents. In that sense we are somewhat unusual as far as large chambers go.

We have no physician in residence on the island. The medical support comes from the University County Hospital Emergency Room. They have a very active training programme in emergency medicine and as part of that twice a year we give a one week diving medicine course and then those residents are put on call. When we treat a case, a resident and a nurse (we give diving medical courses to nurses in the same department) are flown over by the Sheriff's