The seminar, at the 1996 Undersea and Hyperbaric Medical Society Annual Scientific meeting, on diabetes and diving is, according to my information, likely to be no more informative than the one on asthma. So one is going to have to rely on common sense, a knowledge of diabetes and one's experience in diving medicine to advise patients. Extremely "soft" statistics, enthusiasm from protagonists and a desire to be avant-garde will also influence some medical advisers.

Others will use medical approval for motor vehicle driving as a corollary for diving, despite the vastly different demands of the two environments and the occasional case report showing that even driving for "controlled" insulin dependent drivers is sometimes lethal for them and their passengers.

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Dr Carl Edmonds, who was one of the founders and the first President of SPUMS, is Director of the Diving Medical Centre, 66 Pacific Highway, St Leonards, New South Wales 2065, Australia.

THE WORLD AS IT IS

CHAMBER FAILURE

Harry Oxer

Key Words
Fire, hyperbaric facilities, hyperbaric oxygen, treatment.

The incident

On February 25th 1996 at 1505 on the first floor of a hospital at Yamanishi, Japan, there was an event that rocked the hyperbaric units of the world. There had been an apparent explosion associated with a monoplace chamber, and the violent disruption killed two people, and seriously injured a third.

Professor Hideo Takahashi, president of the Japan Hyperbaric Society and Head of Hyperbaric Medicine at Ngoyo University, gave a special presentation on this tragic accident at the Undersea and Hyperbaric Medicine Society Scientific meeting, in Anchorage, Alaska, in June 1996. This is a report of that presentation.

A 74 year old man was undergoing hyperbaric treatment for the chronic results of a brain infarct. He was recovering slowly, but had expressed a keen desire to have hyperbaric oxygen with a view to accelerating his recovery, and had been accepted for hyperbaric oxygen therapy.

All the treatments in this unit are run by two clinical engineers", as they call the technician operators, under the supervision of one hyperbarically trained neurosurgeon. There were three monoplace chambers in the unit, a 1989 Kawasaki, a 1990 Seechrist, and a 1992 Seechrist.

At the time of the occurrence there were patients in two of the chambers There were two technician engineers running the chambers, and observing the patients. At the time of the problem nobody was looking at this particular patient as the clinical engineer caring for this patient was speaking to a visiting doctor at the door of the room. The other was caring for a second patient in another monoplace chamber in the same room. There was an explosion and the 74 year old male in the chamber was severely burned. A hatch blew off one end and killed his 70 year old wife instantly. One of the engineers received a fractured skull from a flying end plate and two other people were slightly injured.

There was no fire and the external fire extinguishers were not activated. There was evidence of an intense fire within the shell which was smoke blackened. The chamber failed in the way in which it was designed to fail. Both the safety relief valves had operated, and there was evidence of soot passing through them, but of course they could not accommodate an explosive force.

The oxygen supply ceased immediately with the explosion and there was no subsequent fire within the unit. The windows of the room were blown out, as were light partition walls, and the ceiling was disrupted.

The patient was 45 minutes into a treatment at 2.7 ATA on 100% oxygen.

Initially a statement was released that all recommended safety procedures had been fully carried out.

However this was subsequently found not to be so. A subsequent statement admitted that the patient was put into the chamber in his own clothes and that no body check or belongings check was done. He had been wrapped in the heavy acrylic blanket in which he had been brought from another hospital.

Investigations

A full investigation was undertaken. The police were involved. The Japanese Hyperbaric Medical Society was involved from the beginning and Seechrist had their own representative on site within 72 hours, but he was not allowed to get to the actual scene for several days. Seechrist, of their own volition, put out a letter to all Seechrist chamber operators advising that use should be suspended until they found out what the problem was. This was despite there being no indication that this was in fact a chamber failure.

The Japan Hyperbaric Medicine Society conducted their own investigation which looked at three aspects of the problem.

The medical indication

There are currently 21 disorders accepted by the Japan Hyperbaric Medicine Society, but chronic brain disorder is not one.

Supervision and observation

Neither of the technicians was actually observing the patient in the chamber at that time. The one who should have been was in fact distracted, facing the other way and speaking to a visiting doctor at the door of the room and also to the wife who was just outside the door. Therefore no signs were seen and nobody observed exactly what happened. However the patient intercom was on loudspeaker and no sound was heard from the patient calling for help or asking for anything. The first sign that anything was amiss was the explosion.

Ignition Source

The first cause that was suggested was static electricity. This was fairly quickly discounted. Many experiments have since been done and, though they had been able to generate static crackles, they were quite unable, under any pressure and oxygen concentration, to cause ignition of any of the substances such as the blanket, mattress, cotton materials, plastic materials or other things that had been within the chamber.

Suspicion fell on a personal heating device called a "Kairo". They are extremely commonly used in Japan and widely available from supermarkets. They are spontaneous heating devices.

They can be bought either as a metal refillable pocket warmer or as a disposable "Kairo". The latter can be bought under the trade name "Mr Hot". They consist of a pouch of material rather like the material holding coffee for a filter coffee machine. The contents look like a black garden mulch. In fact the filling is a mixture of 50% iron filings (powered iron) 50% water with 7 g of activated charcoal, which contains a platinum catalyst, some vermiculite and some salts. This is sealed in a plastic packet to exclude air. If the seal is broken oxidation starts and generates a temperature of 50 to 60° C, slow warmth of up to 40 to 50° C, for up to eight hours. Some of these packages have sticky attachments so they can be stuck on to the clothes of the person, over an area needing warmth, or somewhere around the waist where the warmth is transmitted to the whole body. Placed next to the skin they can cause small burns.

Experiments have been done with "Kairos" in 2.7 bar of oxygen when they have successfully ignited materials similar to those that were in the chamber.

There have been reports of previous occasions when people have taken these into a chamber attached to their clothes. In the most recent one the patient complained of minor burns when the device became too hot quite rapidly. Oxygen and compression were discontinued and the patient was extracted satisfactorily.

In this case the patient did survive initially, but subsequently died of burns. Forensic examination confirmed traces of iron filings powder on some of the clothes of the patient which supports the suggestion that a "Kairo" was the probably cause of ignition.

Seechrist stated that previous fires have occurred from this cause and have been contained inside the chamber. This one was not so contained. Once a fire developed there would be a huge expansion of gases as they heated up, and a subsequent very rapid pressure rise, almost instantaneous.

How the chamber failed

The tie rods failed first and therefore the end caps came off but, because of the pressure, were projected a considerable distance. The flying entrance hatch hit the wife and killed her instantly. The flying cap, possibly from the other end, caused the skull fracture in one of the engineers. The other two people sustained minor injuries only.

The acrylic chamber cylinder survived the initial explosion, but was disrupted by falling when it was blown

off its rest and was damaged by flying debris later. It was, however, still largely intact. The acrylic was blackened on the inside and both the exhaust valves had opened and passed the soot containing gas as planned, but of course they could not cope with the exhalation of the huge amount of gas of an explosion.

Seechrist chambers

The Chief Executive of Seechrist, David Bush, spoke and stated that they had over 700 chambers around the world that had been in use for 20 years. He said that no patient had ever previously been injured.

Seechrist were originally told there had been no fire, therefore initially sent a letter out advising stopping all use of their chambers because of the possibility that the hull had failed. They immediately contacted the Federal Drug Authority (FDA), who later complimented the firm on its responsible and professional approach to the whole thing.

It was quickly established that the chamber had failed in a manner in which it should. Seechrist chambers are constructed in accordance with the requirements of PVHO (Pressure Vessel for Human Occupancy) Division of the ASME (American Society Mechanical Engineers) standards for a chamber building. This requires that it should fail in such a way that the hull of the chamber does not explode or disrupt.

Since this incident, many people have tightened their procedures and have found errors. One patient was trying to get in complete with cigarettes and a lighter! Some units, particularly in Japan, are now trying to use metal detectors such as the portable ones used at airports. They would pick up the iron filings in a package such as the "Kairo".

A few units have changed to compression with air, with oxygen breathing by mask or hood, but this demands meticulous attention to the mask or hood fit to control leakage and the oxygen percentage in the chamber. The Japan Hyperbaric Society, after its review, still recommends compressing all patients in oxygen in these chambers.

Seechrist pointed out that the very small number of other incidents that have occurred in their chambers have not resulted in patient injury and that each has been due to a different problem, none of which has been due to their equipment failing. There have been two or three abnormal events such as unexplained decompressions, though these were put down to inadvertent operator error when investigated.

This is the only major accident for this firm in 20 years with over 700 chambers in operation and with many millions of patient treatments.

There has never been a validated failure of a Seechrist chamber nor an injury resulting from a problem.

Conclusion

A full report will be put out shortly, probably in October. An abbreviated report will appear in the next edition of *Pressure*.

The meeting was given an extremely frank and very detailed verbal report. It illustrated, once again, that recompression of patients, within a hyperbaric facility, in a high oxygen concentration is not without risk. However, the Chief Executive Officer of Seechrist pointed out that any form of compression therapy runs the risk of decompression injury such as barotrauma, even though the risk is very small.

Dr Harry Oxer is Director of the Hyperbaric Medicine Unit at the Fremantle Hospital, PO Box 480, Fremantle, Western Australia 6160. Phone +61-9-431-2233. Fax +61-9-431-2819

A verbal report of this incident was presented at the Hyperbaric Technicians and Nurses Association (HTNA) Meeting in Hobart in August 1996.

MEDICAL CERTIFICATES AND NEW DIVING LEGISLATION IN QUEENSLAND

John Hodges

Key Words
Legal, medicals, medical standards, occupational diving.

Introduction

For the last six years, Queensland's workplace health and safety legislation for underwater diving at a workplace required compliance with *AS 2299 - Occupational Diving.* This is no longer the case with new legislation which came into effect on 2 July 1996. The new legislation, the *Workplace Health and Safety (Underwater Diving Work) Compliance Standard 1996,* has specific requirements about certificates of medical fitness to dive for people doing any underwater diving work.