available for treatment of divers. Access is through the National Safety Council of Australia (NSCA) Gippsland Region, based at 9 Chickerall Street, Morwell. Telephone 051-34-5212 or 051-34-1726, or through Bass Strait Medical Services, 281 Main Street, Bairnsdale. Telephone 051-52-3055 (all hours)(CG Macfarlane, AH: 051-52-4859; P Laverick, AH: 051-52-5233).

The chamber is equipped for mixed gas treatment, as well as saturation, and has complete logistical support, including an ambulance helicopter capable of night flights. The two compartment chamber, which can accommodate two patients lying down or eight seated adults, is mounted on a semitrailer powered by a MAN tandem drive prime mover. Also on the trailer are a diesel generator, a 95 cfm 150 psi compressor, high pressure cylinders of air, medical oxygen and 80/20 Heliox, as well as comfortable living quarters for the attendants. The operational team consists of a treating physician (diving doctor), a diving supervisor and two attendants. Table 2 shows the details of the equipment.

TABLE 2

NSCA MOBILE DECOMPRESSION CHAMBER

SPECIFICATIONS

	Entry Lock	Main Chamber
Length	1.30m (4'3")	2.70m (8'10")
Diameter	1.80m (5'10")	1.80m (5'10")
Volume	3,310L (120cf)	7,252L (259cf)

COMMUNICATIONS

External
- HF
- UHF
- Radiotelephone
- Telephone (Telecom provision fitted)

Internal
- Aqua Air Helium Voice Processor
- 2 National Video Monitors

MEDICAL FACILITIES
- Medical Lock
- 2 Scott oxygen masks
- ECG Input
- Suction unit
- Comprehensive first aid kit
- Oxygen monitor

POWER SOURCE
- 240 Volts/Mains (50m cable carried)
- or
- Dunlite diesel generator 10KVA (fitted)

GAS SUPPLY
- Ingersol Rand Compressor
- Capacity - 98cfm at 150 psi
- Domnick Hunter Filter System
- HP cylinders
- 92,400L (3,300 cf) HeO_2 (80:20)
- 184,800L (6,600 cf) Air
- 92,400L (3,300 cf) Medical O_2

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1. Palmer RP. Minimal-pressure oxygen recompression treatment of decompression sickness. *Med. Jnl. of Aust.* 1968; 2: 174-176.
2. Knight J. First aid for decompression sickness. *The Scuba Diver*. 1982; August: 71-72.

DECOMPRESSION ACCIDENTS IN WESTERN AUSTRALIA

Harry Oxer

The only treatment chamber in Western Australia belongs to the Royal Australian Navy (RAN) and is at HMAS LEEUWIN, inconvenient located in relation to Fremantle Hospital. A new building at Fremantle Hospital is designated as The Hyperbaric Facility, but at the present the money is not available to buy a chamber. So we continue to use the RAN chamber and are very grateful for the Navy's co-operation in treating our patients.

All diving accidents in Western Australia are referred to the Fremantle Hospital. I will discuss six consecutive cases which presented during the early part of 1982.

I would emphasize that we have seen more cases of arterial gas embolism than of decompression sickness. I believe this may be due to success in indoctrinating divers about the use of decompression tables and the dangers of long underwater times. Perhaps we have not done enough to warn them of the dangers of surfacing in an uncontrolled manner even after a very short time at a very shallow depth.

The first patient was a 32 year old sports diver who was operating on a hookah in about 9m of sea water off Augusta. He was by himself, diving from a small boat, when the compressor motor stopped. He nipped up to the surface. Unfortunately he had never heard of having to exhale on the way up. When he got to the surface he fortunately had buoyancy because he was partly paralysed, confused and dyspnoeic. One of the other boats nearby rescued him.

When he got to the hospital in Augusta, he had upper motor neurone signs in both legs, left complete pneumothorax, and gross subcutaneous emphysema in his neck and chest. He was confused and grey. He was managed with 100% oxygen, catheterised, and an intravenous infusion put up. He was given dexamethasone. A chest drain was put in. He was flown to Perth by the Royal Flying Doctor Service. They provide an excellent retrieval service and have three pressurised aircraft so that the patient can be kept at sea level from any part of the store. If a pressurised aircraft is not available, because all the centres of population where people dive are on the coast, we can fly at almost sea level along the coast.

When he arrived in Perth, he was neurologically assessed, then taken to x-ray. There they took his oxygen mask off as it was getting in the way of the x-ray machine. Soon he had a grand mal fit from hypoxia. Due to his pneumothorax, his PO_2 was around 50 when he was breathing oxygen.

He was taken to the chamber and given a short oxygen table. He got somewhat better. He was returned to hospital. He had bilateral up-going plantars and was agitated and confused. So he was sedated with a thiopentane infusion. He had alternating periods of 100% oxygen and air. Next day he had improved somewhat. He still had paralysis of his upward eye movements. It was later that day when I first saw him and wanted to recompress him again. However, the chamber was unavailable so we treated him with oxygen and fortunately he got better.

Of course, with a serious neurological problem he should have been compressed for longer and probably taken deeper. It was five or six hours after the accident by the time he was recompressed.

The second patient was a fit, 39 year old pilot of executive jet aircraft. The plane went unserviceable in Port Hedland and he had a weekend of fairly hectic social activity. On the Monday morning he took off about 0600 with a full passenger load and found that the air conditioning was blowing hot air the whole time (local temperature was 37°C and humidity was 100%) and the pressurisation was not working. He put the aircraft down and sent the passengers away. He worked on the plane all day. He took it up at 11 o'clock when the same things happened. The next day he got authority to fly it back unpressurised without passengers. They flew at 14,000 feet without oxygen for half an hour, but were getting through the fuel. They saw thunder clouds, and went over them at 28,000 feet using fairly low flow oxygen masks. The rest of the flight took 2 to 2 1/2 hours. He did not notice any problems en route but he was very fatigued and unwell after the landing. When he got home he noticed that he had a blotchy rash, and a creepy feeling in his skin. His colleague had no problems at all, in spite of being very overweight and having a beer belly.

Next day he had aches and pains all over, a blotchy rash and was feeling terrible. His GP was ex-RAAF who said 'Hey lad, you just might have decompression sickness' and sent him to me. We recompressed him on a table 6 and within ten minutes he felt absolutely splendid.

One must remember that not all decompression sickness is due to diving. Many years ago when the RAF used to operate unpressurised aircraft to 48,000 feet people regularly got bent. My two episodes were both after dining in nights. The pain usually went on descent but we had chambers to recompress people if necessary. We knew about it. Nowadays people do not know about it as air forces no longer operate unpressurised aircraft at those altitudes. It is worth remembering that a person who feels lousy, is fatigued and has a rash may have decompression sickness.

The third patient was a 24 year old SAS soldier undergoing scuba training. There was a suggestion that he was not doing very well in his training. He had had about 500 minutes of scuba training, and was doing free ascent training with a blacked-out mask. He did it from 10m and then from 18m. There was an instructor with him and they swore that he did everything right, breathed out all the way and so on. I think that is important as there are a number of cases that we have seen and plenty on record where people do all the right things and still get into trouble. You can certainly suffer arterial gas embolism without holding your breath. This appears to be such a case.

At the surface he was asked how he felt. He said that he felt a bit peculiar. So he was helped the four metres to the raft. He needed assistance to remove his gear. He then said that he could feel bubbles rushing up his arms to his head. He was inappropriately jocular and did not answer appropriately. Then he said he could not move his arm and his legs. He was not believed and was stood up and promptly collapsed over to one side. He was quite clearly paralysed on one side.

He was taken to HMAS LEEUWIN, 7 minutes away. During the trip he was given 100% oxygen and by the time he got there he was getting better.

By the time I saw him he had a right bilateral hemianopia, and upper limb weakness, some strange sensory impairment on his right upper chest and pain in it and his balance was impaired. He was clearly knocked off mentally. He had a right sided sore throat which in retrospect was clearly due to subcutaneous emphysema. We recompressed him ninety minutes after the incident and in ten minutes all his signs had gone.

When he got to Fremantle Hospital he still had some mediastinal emphysema with air tracking up into the right side of his neck. He had no further problems and no detectable neurological abnormalities.

The fourth case was the worst of the lot. The incident occurred at Rottnest Island, a holiday island about 12 miles offshore, to a US Navy sailor from the USS Constellation. He was a certified scuba diver instructor (PADI). They were diving on a wreck from a glass bottom boat in about 15 feet of water. After about five minutes he indicated to his buddy that he wanted to surface. He pressed his stomach and indicated something was wrong. They had been eating lots of hamburgers and a fair amount of beer on the previous day. We think that he probably had severe abdominal colic. He came up all doubled up and we feel that he possibly held his breath as a result of that. The dive was only five minutes at fifteen feet. At the surface he lost consciousness and was given expired air resuscitation. He had shaking and rigors and his respirations were said to be rapid and shallow. He was taken to the nursing post on the island where he was given oxygen. When he got to the nursing post the nursing staff phoned the RAN Medical officer who said "Put him head down on his side and give him lots of oxygen."

Then they got in a GP who was on holiday on the island. He said that the patient was hyperventilating and hysterical and gave some IV Valium. He also suggested stopping giving oxygen. After about half an hour to an hour the patient started to respond and improve somewhat and became reasonably orientated but was complaining of photophobia and abdominal cramp. The sister got onto the US Navy which had about six ships and 5000 men in Perth on R&R and asked for a helicopter and a medic with some oxygen to collect the patient. Two and a half hours later a boat arrived, with no medic and no oxygen and only two men on board, to take him back. His condition seemed reasonably stable, so rather unhappily, the sister sent him off and his diving buddy went with him.

During the 7 to 8 mile transit to the USS Constellation he had four to five attacks, which may have been grand mal. The story was that he shook and then stopped breathing and went unconscious. On each occasion he had to have expired air resuscitation from his buddy. There were no medical people in the boat. He was noted to be losing limb power and sensation. When they got to the USS Constellation the medical officer examined him and sent him to HMAS LEEUWIN and by the time he got there he was in deep coma. HMAS LEEUWIN is a cadet training establishment and the clearance diving team that operates the chamber is not always there, they are often at HMAS STIRLING which is 12 miles away on Garden Island. This was so that day. The US Navy had a submarine mother ship in Perth which had a chamber and eventually, six hours after the accident, the man was recompressed in that chamber. He had normal vital signs but his pupils were widely dilated and he was in deep coma. He was recompressed to sixty feet and became conscious within about 10 minutes but he had a very tender abdomen. His reflexes appeared to be intact. He had gross photophobia. He appeared to be alert but appeared not to understand anything. They just could not communicate with him at all. It was noted that he had no sensation from the umbilicus down and that he had no bladder sensation, so he was catheterised. The US Navy discussed the problem with their Experimental Diving Unit at Panama City who recommended that he should be saturated. Some nine hours later he was coherent and could sit up and could remember what had happened and could converse normally. After 24 hours in the chamber he could stand up and eat and so on. So they commenced a very slow decompression of two feet an hour from sixty to ten feet and one foot an hour from ten feet to four, and a hold at four feet and then eventually to the surface. The problem was that during the end of that decompression he got worse again. As the ship was due to leave they decided to decompress him anyway.

They had rung me up during this time and asked me to see him before they took him to sea. Then they rang and said that he was not as well as all that and they might have to leave him. By the time they brought him to me he was apparently alert but totally deaf in the right ear. He had the most profound expressive aphasia that I have ever seen. I would speak to him and he would look at me and then about a minute later he would give a response which was quite logical. He had bilateral, red bulging ear drums. He had the most appalling photophobia that I have ever seen. We had the curtains drawn and blankets up at the windows and when I opened the door he would scream. One could not see any iris, the pupils were so dilated. We could not examine his eyes at all. In very, very dim light he could just count fingers. He was virtually blind, virtually deaf and had peculiar tetanic-like episodes which resembled decerebrate posturing. He was spastic in his lower limbs and had a stocking pattern of sensory loss. We did the usual investigations. The neurologists wanted to do an EEG and a CAT scan but I managed to get him into the chamber before they could.

I got him in the middle of the night and by the time I had had a look at him and decided to contact the US Navy, for more information, it had sailed. So there I was with what I thought was a moderate to middling sick boy on the third day after his accident. We recompressed him in the RAN chamber to sixty feet and decided to saturate him and push oxygen as hard as we could, giving him oxygen 25 minutes on and 5 minutes off. Four hours later he was much improved and was chatting fairly normally. He was hearing better. On the fourth day he maintained his improvement and by the fifth day he was decompressed on a long slow leak and taken to the Fremantle Hospital.

On examination he still had virtually no hearing in his right ear while his left ear was somewhat better. He still had some photophobia. By this time he could read the 6/12 line on a chart at about 50 cm. Still pretty poor but it turned out to be an accommodative paralysis. With lenses he could improve his vision quite a lot. We were pretty pleased about this because it meant that he had not simply knocked off the neurones in his visual cortex. The audiograms showed sensorineural not conductive deafness. So we recompressed him again on the sixth day for very little change. The audiogram showed an 80 decibel loss on the right and 30 off the left. We did not recompress him on the eighth day but did on the ninth. Quite suddenly, about 30 minutes into the recompression, his hearing came back. He picked up the phone and told me, I was outside the chamber, “I can hear the motors outside and I can hear you all talking outside”. When we tested his right ear it was totally normal and his left ear had a 10 to 20 db loss in the 3000 to 6000 cycle range, which one would expect as that was the ear towards the aircraft when working on the flight deck of the aircraft carrier. His vision was still somewhat blurred but improving.

The fifth case was a 38 year old man who decided to do a diving course. He went to a man who advertises a lot as a trainer of divers, but who has not certification of any sort. He normally trains about 50 people at a time by himself. One of the routines is that he puts four scuba sets at the bottom of the 5 metre diving pool. To develop confidence underwater the trainers take a breath from one and swim to the next one and take a breath and so on. The victim took a breath from one and got a mouthful of water. He coughed like blazes, panicked and shot to the surface. No one had told him to breathe out on the way up. He was unconscious for three to four minutes, his pulse was feeble and the rhythm was irregular. He was given oxygen by oxyviva and brought to Fremantle Hospital quite quickly. I got the message over the ambulance radio in my car and so arrived at the same time. He was confused and very shaky. His speech was hesitant and respiration was irregular. He had a non-specific loss of sensation from his elbows down and odd feelings of coldness and numbness in his thighs. His haematocrit was a bit raised. There was nothing on his chest X-ray. I considered that he had had a significant arterial gas embolism. The medical registrar on duty felt that it was a whole load of rubbish.

Within fifteen minutes of recompression he was a changed man, completely normal and we had no further problems with him.

The sixth patient was a 25 year old sports diver using a hookah for some crayfish diving. He had spent about an hour and a half at 25 feet and come up as usual on a slow oblique swim up. He was breathing quite normally all the time. At the surface he had chest pain so he drove himself to hospital. It is an excellent hospital about 400 to 500 miles up the coast. When he arrived there he had a pericardial rub. A pneumomediastinum and a pneumo-pericardium were shown on X-ray. There was subcutaneous emphysema in the lower neck. He had no neurological problems of any sort. The doctor there rang me for advice. I suggested that they gave him 100% oxygen for alternate hours, observe him very carefully and if he did not get better to send him to Fremantle. In fact he got completely better and could not understand all the fuss and wanted to dive the next day.

I have no doubt that man has had a tear of his lung substance and has been very lucky not to have had a tear into a blood vessel. I am sure he is at risk if he dives again.

Another air embolism case was a 23 year RAN diver who surfaced rapidly from 15 feet. I believe that he was using an oxygen set. He had two fits as soon as he surfaced. When he was examined he had a left homonymous hemianopia, left sided weakness and proprioceptive deficit. He was clearly confused. He was recompressed to 165 feet on RN table 63. He made a full objective and subjective recovery after about 20 minutes and had no further problems.

These very brief case histories illustrate firstly that all decompression sickness is not necessarily due to diving. Those of us who are involved in recompression treatment should remember this.

Secondly, arterial gas embolism is much more common than we think. In Western Australia we are certainly seeing it more often than we see decompression sickness.

I believe we should be emphasising the dangers of an uncontrolled ascent, even from shallow depths, more during diver training.

AIR EMBOLISM AND CARBON MONOXIDE POISONING

Charles Hackman

At Prince Henry's Hospital we do not have six hour delays between accident and the chamber. Ours are longer, in my first case the delay was 72 hours.

AIR EMBOLISM

Case A

He was an amateur diver who appears to have suffered a severe air embolus while diving with a highly reputable and experienced diving group. However he was not referred for treatment until he finally contacted his general practitioner two days later.

He was a fit 27 year old man who had been diving regularly at weekends for two years. He had dived to 130 feet for twelve minutes. He ascended at '60 feet a minute' and made brief stops at 30 feet and 10 feet before surfacing. So on the face of it he had done things about right.

He then decided to dive again to use up a bit more of his air. He tried standing upside down on the bottom of the dive boat for several minutes to see if he could become disorientated. He claims that he did not. But he became bored, and swam to the surface quite uneventfully.

On reaching the surface he abruptly felt an odd sensation on his left leg. He looked down to see if he had been hit by a shark, but he had not. Everything looked normal but his leg still felt useless although he was able to move it. He swam over to the boat and managed to half pull himself up the ladder before collapsing back into the water, quite helpless. He did not lose consciousness. He was unable to see or communicate in any way. He was dragged into the boat where he was seen again to be hyperventilating vigorously. Shortly afterwards he began to suffer a series of clonic extensor muscle spasms, which were extremely painful, affecting his back, arms and legs. He virtually went into opisthotonos for periods of five minutes at intervals of about 15 minutes. His companions diagnosed hysterical hyperventilation and made him breathe out of a paper bag. Within 30 to 45 his vision began to return and the spasms subsided. By the time the dive boat reached the shore he was able to stand and walk with some assistance, but he had great difficulty controlling his left leg. Soon afterwards, he developed a severe frontal headache, with nausea and vomiting, but these settled in a few hours when he reached his home.

Over the next two days at home he noticed that he was still feeling tired and unwell. He was having difficulty concentrating. He had generalised aches and pains, mainly affecting the muscles that had been involved in the spasms. He also often collided with the furniture, He was unable to position his left arm accurately for tasks requiring co-ordination, he noticed it particularly when he was trying to pour tea. He was quite unable to read consecutive lines of