The diver had been on mixed gas treatment for 72 hours before the power failure. There would normally have been sufficient reserve facilities available in the unit to cope with a power failure, but on this occasion a second diver was receiving treatment in their other chamber. The unit is now seeking to raise sufficient money to obtain a carbon dioxide "scrubbing" system for the chamber to take care of such an eventuality should it ever occur again.

The diver had apparently been following an accepted Table while he made a no-stop dive but suffered a spinal bend and been flown by helicopter to the treatment centre. Following the recompression treatment he was transferred to a hospital near his home. He has been advised he should never dive again.

Discussion

These cases illustrate the fact that there is far more involved in having a recompression chamber unit for local use than the chamber itself and a staff of willing volunteers. Those who are to be responsible for treatments must not only be trained but be sufficiently experienced to be flexible in their response to the problems peculiar to each patient, and to unexpected external factors such as are reported here. They must be a team with a clear basic management protocol to ensure that the patient has correct evaluation before recompression is commenced. In Case 1 the incident depth is unknown, nor how far he sank before being recovered, but the depths can be assumed not to be great or there would have been a recompression chamber (RCC) at the dive site. The use of recompression down to 50 msw (165 fsw) gauge a trial of 100% oxygen at 18 msw (60 fsw) gauge made the case management more difficult than necessary. However recompression to 50 msw for suspected air embolism is still recommended by many authorities. Both the patient and those treatment him were very fortunate that his pneumothorax did not produce serious clinical symptoms during the ascent phase in the chamber.

In Case 2, the fact that the patient was on a mixed gas therapy implies that the staff of this recompression unit was experienced in the management of serious and complicated cases. Yet despite this it seems that their "disaster plan" was quite inadequate to cover total power failure when both their chambers were in use. There was too great a trust that a power cut would never occur while their facilities were fully extended. They had forgotten Murphy's Law! They would have benefited from remembering how "Papa Topside" anticipated just such a problem and devised a simple answer. Wartime submariners would have told them to scatter sodasorb on the chamber floor.

In the post-war years of rapid developments in diving one of the notable characters who entered the United States Navy (USN) Medical Corps, after an active and unusual stint in general practice, was Dr George Bond. He realised that some problem might result in a "bell" (personnel transfer capsule or PTC) remaining an unexpectedly long period underwater without adequate ventilation. This situation would lead to a dangerous build up of carbon dioxide, so he considered what would be the simplest remedy. He proposed, and successfully chamber tested, a simple no-moving-parts carbon dioxide scrubber. This consisted of one or two pairs of pantyhose filled with sodasorb. Lateral thinkers consider the objective (exposure of sodasorb to the carbon dioxide loaded air) rather than concentrating on modification of the mechanical method which is giving trouble. Dr Bond's paper was reprinted in the SPUMS Journal 1979, April-Sept, p 41-45 and is reprinted in this issue for the benefit of our newer members and as a tribute to the memory of an intelligent and humane Diving Doctor.

These cases are presented because there is a tendency on the part of both divers and civil authorities to under-appreciate the problems which may arise in association with the management of a safe and efficient recompression facility. The sources of these case histories are thanked for making them available for use in this paper. In the interests of confidentiality the sources are not stated here.

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ASTHMA AND DIVING
A CASE REPORT

CJ Lowry
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The patient, aged 33 years, had been a qualified diver for six years. He was a known asthmatic and had been observed to use Ventolin aerosol frequently in the preceding week. He had no hospital admissions for asthma.

The dive was off Boat Harbour, near Kernell, on Sunday, 11 May 1986. His buddy was a female friend, of recent acquaintance and who had just completed her C Card certification. At no stage did they descend more than 30 feet in depth, and they were underwater for approximately 20-30 minutes prior to the patient signalling that he would ascend and get his bearings. He proceeded to do this, leaving the female diver on the sea bed. He then returned to her, in a state of some apprehension. He signalled that they should surface, and then he proceeded to do so at a considerable rate, faster than she thought safe. Nevertheless she continued with him because he seemed to be in distress, and arrived on the surface soon after him. He was thrashing around with his hands, started swimming overarm and had taken his regulator out of his mouth. She attempted

to ditch his weight belt (he was not wearing a BC) but failed because he fought her off. She then tried to pull him towards shore. She spoke to him but he did not reply. His face was white and he looked terrible. He then appeared to lose consciousness and went quite limp.

She continued towards the coast line, which unfortunately was a very rocky area with waves beating on it. With her own buoyancy vest inflated, she managed to hang on to him until she got him to the rocky sea shore. The waves kept pushing her onto the rocks, and then drawing them both off. She feels that he probably aspirated some sea water during this time, and they both sustained many lacerations from the rocks. Several times she attempted to give mouth-to-mouth ventilation. At times he appeared quite stiff but it is not clear whether he actually convulsed.

After approximately ten minutes they were rescued by a group of on-lookers, and taken to the road. The patient remained unconscious, and finally the ambulance and Westpac helicopter arrived concurrently, but it was decided to transfer him to HMAS Penguin by helicopter for recompression therapy.

Mouth-to-mouth respiration and external cardiac massage were carried out once he had reached the roadway, and during transport IV Haemaccel and oxygen were administered. It was also continued until he was taken to HMAS Penguin, where further assessment took place prior to recompression. He was noted to be comatose, unresponsive but breathing spontaneously. It was decided to compress him to 18 metres on 100% oxygen.

There was great difficulty in maintaining adequate air entry, and at 18 metres the arterial oxygen only reached about 70 torr. It remained around 50 torr during subsequent ascent. The arterial carbon dioxide levels were usually above 100 throughout. The pH was below 7.01.

The patient was gradually brought back to the surface, with only a little worsening of the arterial oxygen levels, over a period of five hours. At that stage he was on a respirator, with an endotracheal tube inserted and with positive end expiratory pressure (PEEP), of an indefinite amount (chamber conditions made this difficult to assess).

On surfacing he was transferred to Royal North Shore Hospital Intensive Care Unit, where ventilation with 100% oxygen was continued. A radial arterial line and a Swan Ganz pulmonary artery catheter were inserted.

On 100% O_2 (12 x 700 ml a minute) with 10 cm PEEP, the blood gases were:

	Arterial	Mixed Venous
PO_2	72 torr	35 tort
PCO_2	49 tort	58 torr
pH	7.30	7.21
Base excess	-3.3	-4.8

He was noted to have been mildly hypothermic, with 35.4° C and hypotensive with a systolic blood pressure of 80. Aramine boluses and a dopamine infusion were initiated to ensure the blood pressure remained above 95. He had a tachycardia of 130-160. A space blanket was used to retain heat.

On examination there was widespread inspiratory and expiratory rhonchi. Nebulised Ventolin together and an aminophylline infusion were commenced and PEEP was increased.

The chest x-rays showed gross pulmonary oedema, which was consistent with his widespread inspiratory and expiratory rhonchi. There was no pneumothorax or evidence of mediastinal emphysema.

The next day (day 2), there was some improvement in respiratory and cardiovascular function, with maintained urinary output. His arterial gases: on a FiO_2 of 70% were

PO_2 = 144 torr, PCO_2 = 50 torr, pH = 7.33, Base excess = +6.3

Several episodes of generalised fitting with myoclonic jerks were noted and thought to be post-hypoxic.

He was then gradually weaned from 70% FiO_2 and 17.5 cm of water continuous positive airway pressure (CPAP) to 50% FiO_2 and 10 cm of water PEEP. Arterial gases then were:

PO_2 = 83 torr, PCO_2 = 40 torr, pH = 7.43, Base excess = +3.2

EEG showed flow waves consistent with hypoxia and the CAT scan was normal. He had developed a temperature of 38° C. He was weaned from the dopamine infusion.

Ventolin, aminophylline and hydrocortisone were continued, as were the other supportive measures.

On days 3 and 4 he was still unresponsive to painful stimuli, and there were several episodes of generalised fitting and frequent myoclonic jerks.

On day 5 he was neurologically lighter, the myoclonic jerks were infrequent and arterial blood gases on FiO_2 50% with CPAP were:

PO_2 = 93 torr, PCO_2 = 45 torr, pH = 7.46

A tracheostomy was performed.

On days 7 and 8 the patient responded to simple commands, looking around. Over the next few weeks he had several setbacks with bowel obstruction, septicaemia, required further respiratory support but continued to improve neurologically so that at 5 weeks he was orientated in time

and space, with global cognitive problems associated with moderate frontal (behavioural) problems. There was a residual dysarrthria, a left hemiparesis, and ataxic gait and myoclonic jerks. The speech therapist stated that there was no expressive dysphasia, but jerky stuttering type speech appeared to be related to myoclonic jerks. The EEG irregularities with mixed theta and delta components of low voltage. There was not specific localisation and no myoclonic activity on the EMG.

He was then transferred to the Head Injuries Unit at Lidcombe State Hospital. He claims that he will continue diving together with motor bike riding. He said there was no previous history of head injury. He had been home on weekend leave and had apparently got drunk with his mates. His social activities also included flirting with other patients.

A psychometric performance was carried out and the following report was made:

Due to the pronounced myoclonus, it is not possible to administer the full test battery. Of the tests that were administered, his motor difficulties produced slowed responses which were reflected in the results for the Digits symbol and Bourden-Wiersma tests, both speed and tensions tests, the overall results were lower than our normal range. His performance in the Bourden-Wiersma tests, however, was extremely accurate showing that his attention abilities are certainly intact.

The results for the CFF test are on the lower end of our normal range. This result is difficult to interpret as he was extremely variable, again most probably due to his myoclonus. The variability was much greater for his right eye and right hand.

The short-term memory was within normal limits as was his ability to learn new material. These results suggest his problems stem mainly from the motor regions.

Further information obtained later indicated that the patient had had a medical from his own General Practitioner and had completed a diving course in 1980. He used Ventolin before every dive and indeed had a pocket built into his wetsuit to hold the aerosol.

DIAGNOSES:

(1) Asthma
(2) Cerebral arterial gas embolism
(3) Near-drowning

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PAPERS OF INTEREST FROM OTHER JOURNALS

EMERGENCY SCRUBBING

Dr George Bond

Since we had the one-time occasion to surface the PTC (personnel transfer capsule) with its human cargo as an emergency we have had deep concern about the reliability of the CO_2 scrubber system of the capsule. Looking ahead to the ever-present possibility that a loaded PTC might have to survive as long as eight hours without ventilation, we cast about for a passive system of CO_2 scrubbing quite independent of electrical power. Clearly a system of random scattering of sodasorb within such a habitat was untenable. Likewise individual closed-circuit breathing units seemed inadvisable. But how about simply filling a few ladies' nylon pantyhose with the absorbent and hanging them in the chamber? The idea had appeal despite its naively so we launched the project, using two pairs of pantyhose, one black and the other red, filled with a total of 8.6 kilos of the sodasorb.

For the actual experiment we "locked" four volunteers (one female) in the inner lock of the Draeger chamber, which has a 3000 litre volume, supplied them with an oxygen monitor and a batch of Draeger CO_2 sniffer tubes, and left it up to the pantyhose array to do its bit. In order to provide for metabolic oxygen requirements I maintained a constant flow of 2.5 litres per minute of oxygen, which perfectly kept their atmosphere at 21% oxygen throughout the procedure. Both the carbon dioxide and oxygen levels were determined inside the chamber at 15 minute intervals and recorded outside, while I maintained more or less constant visual and voice contact with our subjects.

As you might guess, Morgan Wells and I were a bit edgy at first since the CO_2 levels in this situation could be expected to rise at a rate of 0.82% every fifteen minutes, which gives little leeway. Still, we had plenty of safeguards so we started the show on time.

Both Morgan and I were a little stunned when the first 15 minutes' reading came out a fat 1.5% and rose quickly thereafter to 2.25%. Still, we had some faith in the system and stuck to our guns. Sure enough, as the chamber humidity commenced to rise, the galloping slope simmered down, and after almost three hours stayed steady between 2.75% and 3.0%. By this time we were already designing the MK II Pantyhose Scrubber, one capable of 75% efficiency, so we called the game and released our volunteers, who were none the worse for their experience. Tomorrow the MK II will be made up, sealed in plastic bags, and duly installed in the PTC.

Improvised, and at-the-scene, experimental work is fascinating. I find it instils a sense of confidence in the aquanauts as well.