

Doctor to the divers

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HMNZS Pukaki was returning from the Christmas Island hydrogen bomb tests in 1957 and we called at the northern Cook Island of Manihiki. There was no anchorage and the ship just steamed up and down the reef whilst the lucky members of the crew were taken ashore over the reef edge by longboats. I was asked to see one of the islanders in the village on the other side of the lagoon. He was a pearl shell diver. A couple of months earlier he had been hauled from the water after a heavy day's shell gathering, and had been unable to walk since. 'Taravana' they said. Paraplegia, this new doctor thought, but my training had not included anything of underwater medicine. In fact, the subject did not exist outside naval diving manuals. Sadly, I had not much to offer on this most isolated of Pacific islands. However, after our return to Auckland the Director of Naval Medical Services handed me the RN Manual, saying "Read this, my boy, you are to be the doctor to the divers."

A diving operation was to be undertaken in deep water off the coast of Great Barrier Island, to calibrate a submarine detection apparatus. The diving tender, an old tug called *Manawanui*, was to be accompanied by the oceanographic research vessel *HMNZS Tui* which would carry a recompression chamber capable of simulated depths of 100 ft. At our base in the dockyard a larger chamber with a 300 ft depth capability was installed for training and treatment.

The operation required the divers to move a steel arm following surface instructions at a depth of 250 ft. On one dive, after achieving this with some difficulty, the lead diver was back on the surface after a prolonged decompression on air and oxygen. We were all relaxing, time for a 'tot', but the diver said "No thanks, I don't feel like it." He had a

preoccupied look. Then I saw him rubbing his left shoulder. Yes, it was hurting, he said. In the chamber at its maximum 100 ft level he was completely better, so he was decompressed in accordance with the treatment schedule. Fortunately, he did not get bent again.

After this I decided that I had better get to know more about the whole business of diving so I asked to do the basic diving courses. The first was the 'shallow water' course in which we learnt how to use oxygen rebreathing apparatus to do ship's bottom searches. As a diving system it was anything but foolproof, and could and did go wrong in many different ways. At that time, I was introduced to the service principle that being called "Sir!" did not afford protection from forthright verbal attacks on one's capabilities by the instructors if their advice was ignored. Those of us who performed a satisfactory bottom search at night and passed were given a special treat. We were able to have a dive in less murky water with an open circuit air breathing set. And so I was introduced to a new and growing sport.

Straight after getting married and my joining the Royal New Zealand Navy, Eileen and I had sailed for New Zealand (NZ) from England in June 1956. Ambitions to travel, have a nautical field of work, and to marry, all seemed to combine nicely. It was not long after our arrival in the Pacific, therefore, that the events above occurred. In 1960, I returned to England for postgraduate study, for which I decided to do Occupational Medicine. On the completion of this I was allowed to go to the Royal Naval Physiological Laboratory (RNPL) for six months before returning to NZ – a splendid opportunity. At that time, Peter Bennett was at RNPL working on nitrogen narcosis, and Val Hempleman was formulating helium diving tables. My mentor was the Senior Medical Officer, Eric MacKay. Also there in 1961 was Rex Grey from the Royal Australian Navy, who was putting his efforts into formulating a reference base and library for the recently established School of Underwater Medicine.

I decided to see what had happened to all the 'bent' divers for whom I could find records. Although I could find only 137 case records, this was enough to show that the treatment tables had a dubious scientific background, and a rather uncertain practical effectiveness. My survey also indicated that prolonged oxygen administration at the shallower depths and a continuous leak away of pressure instead of stages could be of benefit. Unfortunately, I was unable myself to pursue these ideas because I had to return to NZ and other duties. Since then, of course, these principles have become standard practice as a result of others' research.

At the end of this time I was able to go to Norway on *HMS Reclaim*, where the helium tables designed by Val Hemplemen were to undergo trials in the sheltered deep waters of Sjordfiord, near Bergen. We had some serious cases of decompression sickness (DCS), which showed again that the diagnosis was often not as plain and well defined as the diving manuals would have one believe. It was also clear that severe fatigue and general malaise could be the precursors of more serious problems. This provides a considerable difficulty as it is obviously impossible to recompress every tired diver who feels a bit 'crook', and there is no way of measuring such symptoms.

Back in New Zealand, dive shops opened to cater for the increasing number of amateur sporting divers, and the New Zealand Underwater Association provided a national body for the increasing number of dive clubs. I was asked to become its medical adviser and we initiated a scheme of medical examinations for recreational diving candidates. I also became consultant to the Department of Labour and a similar programme was introduced for the working diver.

Our naval recompression chamber was the only treatment facility in the country, and its availability to the civilian population was fully accepted by the Navy. Fortunately, the actual number of cases requiring chamber treatments remained relatively few, though always very well publicised in the media. The civilian cases all presented after a considerable delay, because of diagnosis and evacuation difficulties, and very few were what could be classified as 'simple' limb-pain bends.

One weekend we had a call about a badly bent diver being brought in by boat from around Kawau. The chamber was prepared and the staff called in. I went to meet the boat. The diver had been dead since he had been retrieved from the water, drowned, but the skipper hadn't liked to say so over the radio! He had a dry suit on, with a small right-angled tear on the shoulder, doubtless torn on the edge of the crayfish hole he had not been able to get himself out of. I was always surprised at how little the divers who came to us seemed to know of the details of their diving schedules. Depths and times were vague; one even said to me "Oh you'll have to ask my buddy, he always checks that."

After giving a talk to one club on the hazards of diving, a member of the audience said to me "We often dive to 200

ft, but we never get nitrogen narcosis." With the cooperation of the naval diving team we arranged for them to have a dry recompression chamber (RCC) dive to 150 fsw. They all disregarded the tests we had given them, and relaxed into hilarity generated in part by the 'narks' and also the unexpected 'Donald Duck' voice quality at pressure. "Let's have a shong," was the call as they decided to forgo the simple arithmetical task that I had requested. We managed to do this for quite a number of local clubs on Saturday mornings, always with the same result. The party was always brought to an abrupt halt by the cold fog in the chamber produced by the decompression.

I had completed my commitment to the Navy in 1964 and had entered general practice in Devonport so was well placed to continue as their consultant in underwater medicine. For this decade, our navy maintained its deep diving capability with annual training during the summer in Mercury Bay. The *Manawanui* was based in Whitianga for this period, and set out early every morning for calm and deep water. The operation entailed gradually working up to dives of 300 ft with traditional 'hard hat' and surface-supplied air apparatus. It was my very pleasant naval reserve duty to go with them as their medical officer. Considering that the diving was at the very margin of safety we were fortunate that only one diver suffered DCS. He was evacuated by helicopter to Devonport. The limb pain quickly responded to treatment in the RCC and he continued his career as a naval diver without further trouble.

The *Wahine*, a Cook Strait ferry, sank in the entrance to Wellington Harbour in a storm in April 1968 with the loss of many lives. This began a prolonged salvage and diving operation. Initially, this was mostly in shallow water, about 40 ft, and was DCS free. Then the wreck shifted into deeper water and broke up. The diving was then deeper and harder, to cut the wreck into moveable sections. The first 'bend' was the senior diver of the team in March 1970. He recognised his limb pains immediately and travelled up to us in Auckland by a normal commercial flight, which hurt him even more. He was quite aggressively blunt about not having any general medical examinations. Initial treatment with the new Goodman and Workman oxygen tables did not relieve his symptoms, but after a short while at 165 ft he was better. He also had a marked limp, apparently present for many years. An X-ray showed almost complete destruction of his left hip from osteonecrosis, and there was widespread involvement of other bones. I was surprised that it was not more painful. The following week another diver came to us with the same symptoms. He had dived 3 1/2 hours at 65 ft, without decompressing. Again the oxygen tables did not relieve his pain but higher pressure did.

I was asked to review safety procedures. It was apparent that monitoring of the dive schedules was difficult and unsatisfactory so, amongst other measures, I suggested the use of a 'decompression meter'. This simple tool was often misused and has been much maligned. From then on to the completion of the salvage, 10,800 hours of diving were

undertaken without further DCS. Later, the same procedures were used with success for the salvage of the *Seawise Princess* (ex Queen Elizabeth) in Hong Kong Harbour.

The annual calendar of the diving world in New Zealand included a 'convention' at Mayor Island on Labour weekend. In 1971 it proved to be a disaster. The first bend occurred on the Saturday afternoon. He was evacuated to Devonport and in spite of a neurological element in his decompression sickness he was successfully treated with a fairly short table. The chamber was again in use the next day for a diver who had been diving to 160 ft and was semi-conscious and virtually quadriplegic. His response to treatment, which included prolonged oxygen at 2 Ata (202 kPa) was disappointing. He was still in the chamber when a third diver arrived on Monday evening.

After a dive to 250 ft this diver had surfaced virtually out of air, and had called across the water for another bottle (his normal practice!), but been unlucky because his support vessel had started to sink. He said that he thought that he might have a touch of the bends, then lapsed into coma. However, when he got to us he was conscious again and complained only of being very tired and weak. We had managed to get our reserve chamber into action, though this did not have any oxygen capability, nor did it have a man lock. However, we had a Viet Nam veteran as an attendant for him and pushing the chamber beyond its proper limit we got him to 165 ft. All to no avail sadly – he became more sleepy, then unconscious and unrouseable, and died. Post-mortem examination failed to reveal any intravascular gas or provide us with an explanation; however, in retrospect there is little doubt that he was suffering from disseminated intravascular coagulation. At that time this was only just becoming recognised as a final pathway in many serious disease processes.

Until this time in New Zealand I think we had been fairly lucky with the number of cases of severe DCS that had occurred. The Poor Knights has accessible and relatively protected cliff faces that run down to a sandy bottom at around 150 ft. In contrast, the Bay of Plenty is potentially a more hazardous area as the popular sites are reefs that do not reach up to the surface. This requires an open water swim from reef top to surface and support vessel. Getting back to the surface to see only a distant mast top when one is at the peak of a swell certainly provokes anxiety. The timing of the convention at the beginning of the season when people tended to be out of practice was also ill-judged, and it has not been repeated.

A trust was set up in the Bay of Plenty to provide a chamber as a memorial to the diver who died. Eventually they managed to get one, but it was not possible to get it integrated into the hospital system. The trust underestimated the ancillary support that was necessary, and the chamber was never used. However, a similar fund-raising exercise in the South Island was more successful, culminating in 1979 with the commissioning in Christchurch of the first

civilian hospital-based multi-place RCC in NZ. The voluntary staff of the unit were trained by the RNZN diving team and myself both at *HMNZS Philomel* and in the new Christchurch facilities.

The naval pattern of management, with a chamber at the diving site, was essentially to treat first and ask questions afterwards. Our chamber was at the dockside at *HMNZS Philomel*, Devonport, on the north shore of Auckland Harbour, at a distance from other medical facilities. This was less than ideal for the civilian sports divers who often had a long journey to get to us, and whose problem might not require recompression. For instance, it was not uncommon to have cases of water inhalation evacuated to us as the 'bends'. Wherever possible I tried to get a chest X-ray, electrocardiogram and blood screening done, speedily of course, before starting a recompression.

The chamber was fitted with a large oxygen cylinder to which we fitted a full face mask with a regulator on the side. This enabled the comfortable breathing of 100% oxygen, after the decompression schedule had got back to 2 Ata (202 kPa). We could also use the shorter 'minimal pressure oxygen recompression' Goodman and Workman tables. There were also hints from conferences and papers that other methods of management, including heparin, dextran, and steroids, could be of benefit. Unfortunately, by the nature of things these reports could incorporate only small numbers of patients and were therefore insufficiently conclusive to be integrated into our treatment protocols.

A fit young diver who, I believe, made a considerable sum illegally diving for crayfish was evacuated to us after a dive to 110 fsw for 25 minutes. Shortly after surfacing he felt that the right side of his face and left side of his body were paralysed. However, by the time that he arrived his symptoms had resolved and he was not recompressed. Three months later he came back after a dive of 80 ft for 20 minutes, with partial paralysis of the right arm and leg and other minor neurological signs. He was successfully recompressed this time using the oxygen table. I advised him that he was particularly 'bends prone' and that he should give up diving. But his plan was to dive again, far distant from fisheries inspectors...and medical aid. I offered him a trial simulated dive in the RCC, to which he agreed. We decided on 140 ft for 20 minutes with decompression according to the RN tables. The profile was chosen because it provided considerable decompression stress, but was one which he could have managed himself in open water.

I accompanied him as attendant and the dive proceeded uneventfully, but shortly after saying at the 20 ft stop "I don't think this will prove anything," he said "I feel crook, and I have a pain at the back of my neck." At the 10 ft stop he complained of double vision and started to mumble, soon becoming unconscious. He had a macular purple-red rash over his trunk and arms, his left hand was tightly clenched and pupils fixed, dilated and deviated to the right. Then his left arm and hand started jerking. He was immediately

FIGURE 1. Tony Slark in November 2000

recompressed to 60 ft on oxygen and within five minutes he was fully conscious, the rash had gone and he was without neurological signs. I felt rather better too! "What happened?" he asked. "Oh, nothing much," I replied, "I'll tell you all about it when we get you out of here." He took my advice and has never dived again.

From the early 1970s I was able as preceptor to offer final-year medical students an 'elective' in underwater medicine. This was a most rewarding experience. For three months during the summer I was able to take them diving frequently, and we had informal seminars every week. Their part of the bargain was to keep a journal and to write a referenced essay on one of the countless questions that had come up in our discussions. Some of these essays have been published in this journal. The programme was well received at the Medical School, and several of the students have remained in contact and have become my very good friends.

We had occasional requests from local hospitals to give various unfortunate patients who had gas gangrene treatments in our chamber. We treated four with success. An 84-year-old man was declined as he was moribund by the time he got to us. He just survived the return journey to the hospital by ambulance. A six-year-old girl whose knee wound had become infected with *Clostridium perfringens* got better after only two treatments. I have always been surprised that we had so few requests for our services.

At one time several patients suffering from multiple sclerosis (MS) sought chamber treatments. This was not easy as it was certainly on the fringe of orthodoxy and the

rules for admission to the Naval Hospital did not extend to non-service personnel suffering from general medical conditions. However, we did manage to slip in a few. Only one benefited. Her circulation in both lower legs was compromised by long years in a wheel chair. Feet that were cold and blue became pink and warm, but it was regrettably a short-term benefit. Jersey, in the Channel Isles, had a recompression chamber donated specifically for the treatment of MS, which I was able to visit, but I have not seen an analysis of their results.

Developments in diving and hyperbaric medicine have been slow in New Zealand. After many years of struggle using enthusiastic volunteers, the Christchurch facility gradually developed. Their chamber has now been replaced by a state-of-the-art facility, which I was invited to formally open in November 2000 (Figure 1), and a full hyperbaric medicine service provided. The RNZN also now has an excellent unit adjacent to the Naval Hospital, which has provided a comprehensive service since December 1990. All naval medical officers can expect proper training in this and all aspects of marine medicine.

My one regret is that I could not spend more time with this fascinating subject. The only opportunity would have been to switch to the Royal Navy. Although this might have been possible it would have meant leaving New Zealand for good, and I was not prepared to do this. With the necessity to earn a normal medical living here, I could devote only a portion of my time to underwater medicine. However, for many years I was able to keep up my association with the RNPL with visits and at conferences. The subject provided excellent justification for interesting travel, and meeting interesting people. Now there are good textbooks on the subject, the Undersea and Hyperbaric Medicine Society has provided an academic foundation for keeping abreast of developments, and this work is augmented by the SPUMS, which, always great for comradeship and the annual scientific meetings, has this excellent journal. No longer does the flutter-clatter of a helicopter going past my veranda on a fine Sunday afternoon mean a night at the RCC.

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The database of randomised controlled trials in hyperbaric medicine developed by Dr Michael Bennett and colleagues at the Prince of Wales Diving and Hyperbaric Medicine Unit is at:

<www.hboevidence.com>