

Now and then – tales from SUMU

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Autobiography, diving research, military diving, history, general interest

If this bores you, blame the Editor – he asked for a memoir of my time in the field, claiming that some might be interested. I think he is short of material or a spy for my pay master, the Royal Australian Navy (RAN), who wants to know what the old fool does.

My main academic interest at university was animal climate physiology. The postgraduate part of this had me involved with oxygen sensors in an attempt to measure the oxygen consumption of grazing sheep. A rural recession dried up the research funds and meant that there was small chance of work in this area. So, in an attempt to find a job, I looked for other areas where my experience could be used.

As part of this search, I developed the idea of a rebreathing set with gas analyser control of the oxygen concentration. I sent an outline of it, to “The RAN, Canberra”. Eventually my letter reached someone called Edmonds, from the School of Underwater Medicine (SUMU). He said it was a good idea, but I was too late as the USN and Walter Stark were testing prototype sets that worked that way. He also said to come and have a chat if I was in Sydney and he would tell me more. We met, I laughed at his jokes, the possibility of a job was mentioned, and eventually I arrived at SUMU in 1972 as the new scientific officer. If I last till my proposed retirement date, it works out at over 36 years in a job that I might do for nothing, if I were rich and needed a hobby, because it has generally been fun.

I count all the 20 Officers-in-Charge, and nearly all the other staff I worked with, as friends. Of these, Carl Edmonds and Des Gorman, both ex-presidents of SPUMS and frequent writers in this journal, will be better known to readers than most of the others.

Carl was hoping that we could develop a telemetry system to monitor divers and diving sets. It never reached the stage of being a reliable tool because of waterproofing problems and the difficulties in transducer design for conditions of fluctuating temperature and pressure. When working with Carl, you soon get involved in several tasks. One day he announced that we were going to rewrite and expand the RAN diving medical guidance notes. Chris Lowry and I said “Yes, Boss”. When we had finished, the Navy showed no interest in having such a comprehensive guide, and the first edition of *Diving and subaquatic medicine* came out as a private venture. Under the modern rules, the Navy would censor it and take any profits. I cannot see them being happy with a book that is dedicated to a dead dog and cites *Penthouse* as a reference.

Carl was also interested in diving audiology, so Frank Blackwood and I spent time trying to develop a device to measure the pressure a subject needed to exert to perform the Valsalva manoeuvre. Eventually we reverted to impedance audiometry as we could not get any of the published designs to work reliably.

This was one of several occasions where I spent months on a method and found that it did not work for me. Another is the use of jelly to simulate tissue gas uptake and bubble formation. This has been reported in the literature several times, but I tried for months and never got repeatable results. Are some scientists like chefs, who omit a key ingredient from a recipe to preserve their advantage? I believe “typical results are shown in Figure 1”, often means “the best result we ever got is shown in Figure 1”. I am a modest chap, but not modest enough to accept the other explanation (that I am not very smart).

In about 1975, we were asked to develop a new oxygen diving set with longer endurance than those available on the market. We got to working prototypes several times. But each time the officer who tasked us to do the work had moved on and his replacement had different ideas on what was needed. So, we kept changing it and eventually people got sick of waiting and a German set, with lower endurance and lacking other features the Navy wanted, was purchased. I still regret this, as there was a chance for an Australian firm to do well in diving gear production.

Late one morning during a trial dive an admiral came past, so the diver was called up to show off the new set. The diver took the mouthpiece out and promptly threw up all over the great man’s shoes. The admiral assumed this was caused by the set and was not impressed. My subsequent questioning revealed that the diver’s morning tea had been two pies and a milkshake – convincing proof of the need for the rule on eating before diving.

Another task from that time came from a statement from the Officer-in-Charge of the RAN Diving School. He thought his trainees were not getting enough food, and their falling body weights tended to support this belief. The Navy rules would not allow more money for food without proof, so we studied a diving course in detail. We found that during intensive training, they were about 4000 kJoules per day short of balance. The divers said thanks, that result would allow them to buy more food. I said a food shortage was only one of the possible conclusions; they were getting five hours of sleep and about 15-minute meal breaks, so possibly they were too tired or too rushed to eat.

We repeated the study, with agreement that they could have more time for sleep and longer meal breaks. This time they were about 2000 kJoules short, except for one man who ate about half a loaf of bread each day with butter and jam. The outcome was that they got more food and sleep, and the students were better trained. Another interesting and unexpected outcome was that diving time per day also increased markedly. I think the old way left people too tired to work well.

When Des Gorman came along we developed a greater interest in gas embolism, because it was the topic of his PhD thesis. His experiments were conducted on rabbits and the rabbit population probably thought there was a new disease that eliminated any animal that strayed into Mosman.

Des had developed this interest through being involved with submarines and submarine escape with the Royal Navy (RN). As a result, we also became a centre of information on submarine escape, rescue and atmosphere control. After Des and others who had started us in the field moved on, it became one of my areas of interest. This has been fun as I have gone to Canada, the UK, USA, Sweden, Germany and Malaysia for submarine-related conferences. At most of these I presented papers (Figure 1).

My early work was on emergency scrubbing methods that did not need a ship's power. The first of these was a man pedalling on a stationary bike and driving a pump that used Frank Blackwood's wife's old vacuum cleaner as an air pump. That system could scrub air for a complete crew, but was hard work, which might have been difficult for a survivor on short rations. My other proposed system was to have a portion of the crew exhaling through a carbon dioxide-removing canister. They inhaled the CO₂ put into the atmosphere by the rest of the crew and scrubbed it for them, about half the crew needed to be using canisters. Later I became interested in the limits for when to escape; for example, the gas limits for situations where one had to choose between high risks of gas toxicity in the boat or of drowning on the surface.

My standard rule to make travel worthwhile is to take at least a week of leave with the trip, to get over the jetlag and reduce the risk of sleeping during the less interesting papers. I nearly caused a diplomatic incident at a Swedish conference. The speakers were sitting in order along the front row. The man who was to speak two after me was accompanied by a woman who did not shut up during any of the papers. If an opportunity had been available, I would have suggested that she gossip outside. Fortunately the speaker she was talking to got his turn before I got a chance to mouth on. He was the designer of the *Kursk* and she was his simultaneous translator!

I have several regrets – the first is the lost opportunity in possibly providing a better treatment for decompression sickness (DCS). Carl was/is a strong believer in choosing

the treatment pressure that was needed for satisfactory relief, rather than a depth in a table. He combined it with a continuous bleed pressure reduction, minimum or no air breathing breaks, and aggressive use of IV fluids. His treatments were conducted in a very noisy chamber; this often had a strong aversive power, so the sufferer may have denied any remaining symptoms, and improved his results.

The next few medical officers (MOs) tended to follow Carl's line. Then it was suggested that there was no comparison trial between this treatment and the standard ones to prove that the Edmonds approach was better, so we should be using the free world standard, USN Table 6/RN 62, as this was widely accepted as "best practice". If you look at the first papers on those tables, they came into use with far less preliminary work than Carl's efforts. Also there is no logic in 18 metres rather than 10 or 15 metres, and a good case can be made for minimum or no air breaks.

A comparison trial would have been great, but was not contemplated at the time. I later considered a paper based on trying to match cases treated both ways, but decided that it was not reliable because some results may indicate only the variable bias of MOs toward reporting a good result. If you have spent \$X,000 of the taxpayers' money, there is little incentive to say after the treatment that the clown (patient) was probably suffering a pulled leg muscle and an anxiety attack, not DCS, and you did not pick this up before you treated him. Also, some of the reports read: name, (rank and number, if from the RAN), date, suffering DCS, treated with Table N, discharged well, signed X; end of report. This is hardly enough clinical evidence to base any analysis on.

My next regret is the growth of regulations and regulatory bodies who take little account of the real world. Before the Canadian (DCIEM) tables came along, the RAN was using air decompression tables from the RN. With them, the incidence of decompression sickness was unacceptable in some dives. Our preferred option was to use a short, deep stop, within the tables, expecting that would improve their safety with little effort. The alternative offered was to spend several years in a trial that would have given numerous cases of DCS. We hoped that the bosses would take the deep stops option. But some giant brain took the proposal to mean that we really wanted to bend many divers. So they saddled us with an experimental diving ethics procedure, borrowed from the UK, which made no allowance for degrees of risk. It considered a dive with a real risk and a dive to verify that a procedure, like the deep stop, should be safer than normal, as equally risky experimental dives. The other loser was the taxpayer, as it combined experimental dives and deep dives together, for extra pay. For a while there was a rush to do any deep dive for the cash.

Now we have a medical ethics procedure that covers the whole defence area. I accept that in some areas it serves a vital need, for example in drug trials. But the paperwork

tends to discourage small and interesting, harmless experiments. Also, the rules tend to require one to have some expertise to start work in an area. Under this process, Carl and Des would have found it difficult to start on the work they produced, as they started as beginners. Experts have to develop; they are not born “expertised”. Also, often at the beginning, Carl had no clear idea of the answer to some of the problems he solved, so if he had submitted an ethics proposal, it would probably have been stamped: REJECTED. Reasons: no clear hypothesis, statistics lacking, shows little knowledge of the topic.

Both of them would now find their animal work difficult because of the animal protection rules. To do any animal work in New South Wales, the institution is now required to meet 14 pages of legislative rules. The rabbits that had the honour of being the subjects in the Gorman experiments came here in a standard cage, warm and dry, waited for a couple of hours nibbling some lettuce, and then were anaesthetised, and did not wake. I think they were better off than my neighbour’s pet rabbits – they live outside, occasionally they get out and some have been eaten by dogs.

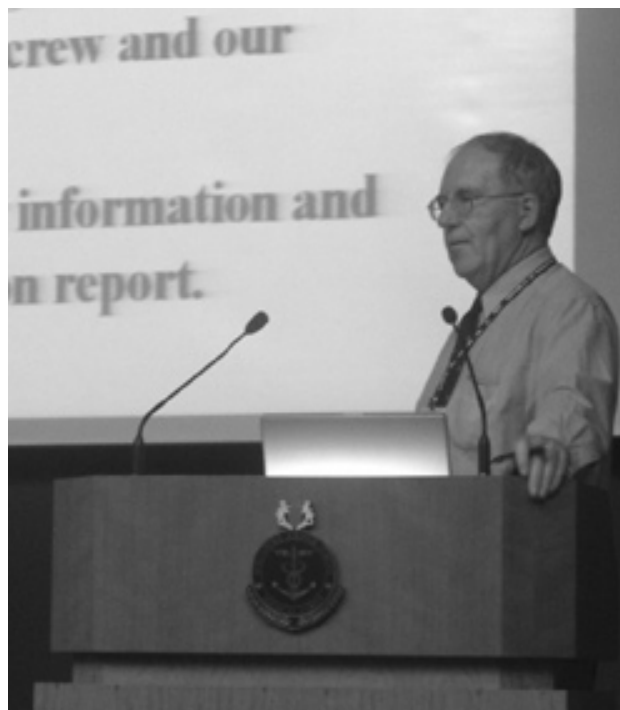
Now we would be required to have an animal house, a vet, and lots of other animal protection devices. So, small places are excluded from animal work. If I read the law correctly, you cannot enrol in a degree and use an approval from the university to cover work away from the university – the place where the experiment is being conducted is the area to be certified.

I offer these comments in the hope that any reader who serves on an ethics committee will have some sympathy for the investigator who is trying to start out, or who proposes a low-risk experiment. If you take the argument back further, Boyle, Bert, both Haldanes and Donald would all now be stopped by the RSPCA or an ethics committee. Haldane senior, allowed Haldane junior, then aged about 14, to dive in RN gear from a RN ship in an experimental diving trial. The child welfare department would have also given Haldane senior a hard time.

Carl had a one-man ethics committee. He experimented on himself first and, if he survived without injury, the experiment was repeated on his staff, with care, then on divers. I think self-preservation makes this one-man, golden-rule ethics committee the best in many circumstances, and the paperwork is a lot simpler! Other ethics committees, with rules similar to Carl’s, approved the experiment that got Barry Marshall his Nobel Prize. I will admit that they did not serve John Hunter well.

The Beryl Turner, Pennefather and Peter Sullivan paper on bluebottle stings was performed on ourselves, the staff and a few divers who were near the door when we decided we needed a few more cases to build up the numbers. The words “volunteer” and “ethics” had not been invented.

Figure 1
John Pennefather, in a lecturing pose many
have seen/slept through
(photo courtesy of Singapore Navy)



There was recently an amusing spin off from this work. I went to a well-researched lecture on marine injuries; the speaker listed vinegar as one “cure” for bluebottle stings. I stood on my hind legs and said I disagreed with that statement. He started to challenge me, saying it was from a paper in a refereed journal and what right did I have to criticise it. When I confessed that I was a co-author, he agreed that I could question it.

Another interesting aspect of my job is the strange requests one receives. One was made long ago, before the wreck protection laws were passed. A diver, who is now dead, came to me with a lump of coral. He wanted my assistance with the chemistry needed to dissolve the rock. When I asked why, he invited me to look at it closely. I did so and could see metal. When we dissolved the rock, some old silver coins were revealed. I believe he retired soon after and lived well, so I wonder how many other rocks he treated.

A question from a fish exporter, on whether rebreathing equipment technology could be used to improve the efficiency of exporting live fish, earned me the splendid payment of 2 kg of scallops and some wine. If you put a lot of fish in a tank and seal it with oxygen in the air space, the carbon dioxide (CO₂) dissolved in the water eventually kills them. I suggested soda lime, with a battery-powered aerator to draw air through the canister and bubble it into the water, as a method of removing CO₂. Trials showed that it worked well, but the Hong Kong live-fish buyer decided that he

would migrate instead of becoming a Chinese communist citizen, and the Australian end of the deal did not proceed. Somewhere in the fisheries literature is a paper on improving the survival of fish in a congested tank, with my name on it. I took the scallops and wine payment, as there are rules on people like me accepting money for outside work, but there was nothing in the rules then about gifts. Now the politicians have been greedy and this loophole has been closed.

My last story from this era took place during Des' time at SUMU. A diving instructor came in and said he was hoping to go into business building small recompression chambers (RCCs). We tried to talk him out of it, but he persisted and I gave him some advice. This was to consider a cone-shaped shell to give good stress-resistant properties with minimum weight. Because a head-down position was in fashion for cases of cerebral arterial gas embolism, I suggested that it be designed to tilt, to give head-down posture if needed. Somewhere there is a lapsed US Patent with my name on it for a tilting RCC. The basic design passed to Cowan Engineering, who employed Eric Fink to improve it, and then sold numerous chambers to the US Navy and RAN.

SUMU has always investigated equipment faults in military diving equipment. More recently we have assisted police and coroners with civilian diving deaths on rebreathing equipment. One of these was particularly sad. The lawyer for each party asked me questions that showed he had not read my report, and was trying only to prove that his client had been perfect. The only intelligent questions came from the father of the deceased, who had leave to represent the family. Sadly his son probably unintentionally caused his own death by assuming that rebreathing equipment does not need obsessively careful maintenance.

Life continues to be interesting. Most days give me a new question to answer. When my phone rings, it could be an admiral with a policy question, or an able seaman wanting help with an assignment on maths that I last used about 40 years ago.

Your Editor asked if I could provide a bibliography. I cannot track some of my old efforts, but a few are listed below. Also, if I have done anything useful, it has been to make divers and submarine crews a bit safer, mainly through the efforts of the MOs whom I have helped to train, not writing a dusty paper that is now best forgotten. I offer my best wishes for a healthy life to all of them and my other friends who read this.

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- Edmonds C, Lowry C, **Pennefather J**, Walker R. *Diving and subaquatic medicine*, fourth edition. London: Arnold; 2002.
- **Pennefather J**, McKenzie BJ. A new type of carbon dioxide absorbent canister. *RAN School of Underwater Medicine Report 1/77*; 1977.

Comment: A canister design where the gas to be scrubbed went through a part of the canister twice. It gives better utilisation of the soda lime than normal flow patterns.

- Turner B, **Pennefather J**, Edmonds C. Cardiovascular effects of hot water immersion (suicide soup). *Med J Aust*. 1980; 2: 39-40.

Comment: An examination of the possible problems with using a hot water bath for hypothermia treatment that showed some cardiovascular problems for the 'hot tub' fans.

- Edmonds C, **Pennefather J**, Blackwood F. Manometric audiometry for the evaluation of Eustachian function. *RAN School of Underwater Medicine Report 3/80*; 1980.

Comment: An early demonstration that an impedance audiometer can be used to demonstrate successful ear clearing in a person in whom the examiner is not confident from visual examination that this has occurred.

- **Pennefather J**. Some recent research at the RAN School of Underwater Medicine. *SPUMS J*. 1984; 14: 23-5.

Comment: This article provides details of the diver diet and exercise study mentioned above and an experiment with Beryl Turner and Peter Sullivan on treating bluebottle stings.

- **Pennefather J**. A transportable recompression chamber system. *Proceedings of IX International Congress on Hyperbaric Medicine*, Sydney, Australia; 1987. p. 242-8.

Comment: The 'birth' announcement of what became the Cowan two-man RCC.

Much of John's other work is in inaccessible publications. He would be happy to look for papers for interested readers.