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SOME RECENT RESEARCH AT THE ROYAL AUSTRALIAN NAVY SCHOOL OF UNDERWATER MEDICINE

John Pennefather

I will outline two studies undertaken at the School of Underwater Medicine. The first, a nutrition study, is reported to seek answers to the problems encountered. The second, a study on coelenterate stings, is mentioned again to correct some misapprehensions people got from the published paper.

NUTRITION OF DIVERS

A Clearance Diver in the RAN, undergoes a six month course. The first three weeks are spent learning to dive on air. A bit like a C Card with a lot of extra diving under supervision including night dives, and some PT. The next four weeks are spent learning to dive with oxygen sets. This can be very hard work involving up to 18 hours activity each day. It may include four one hour dives each involving an 1800 metre swim. This phase tends to act as a selection mechanism, people who are not strong or who lack a real drive tend to withdraw and change to another occupation.

The School of Underwater Medicine was asked a basic question about these men. Were they getting enough to eat?

Experiment 1

The first study of the problem was conducted by underwater medicine sailors who each observed one diver, noting his activity and food consumption. From this 14 men days of useable data were collected. This was processed by assigning an energy cost to each activity and an energy content to each part of the diet. The energy costs of each activity were based on published estimates.

The basic flaw was that the food intake was based on "standard" portions. It was not known if the helpings served were bigger or smaller. Also no allowance was made for uneaten food. The results obtained (Table 1) suggested that the food supply may have been inadequate.

Experiment 2

The study was repeated. With the instructor's agreement the students were given 30 minute meal breaks and at least six hours rest. This was because it could have been argued that the subjects in the first trial were too tired to eat or that they did not have time to eat their food. Subjects in the first experiment had as little as five hours sleep and meal breaks as short as ten minutes. In the second experiment the components of one meal selected as average size were weighed. Because of the lack of time and staff, waste was again ignored.

The result of the second study are shown in Table 1, Experiment 2. It will be noted that the intake and balance are closer but the balance is still negative. It will also be noted that although the time available for diving had been reduced, by the longer rest and meal breaks, there had been an increase in diving time. It was also noted that this group was quicker to perform their tasks. It is not possible to state if they were better supervised, or were a better quality group, or if the improved performance was a result of better feeding and more rest.

Experiment 3

The results of these two studies were mentioned in an internal navy report. The conclusion that the Royal Australian Navy might not have been giving its sailors enough food caused considerable concern. As a result the Army Food Science Establishment was directed to examine the problem. They expanded the study by following the weight and body fat content, estimated by skin fold thickness, through a course. They also reported the examination of the energy balance for 15 men days of oxygen diving training. This time food intake was measured as accurately as possible, each component was weighed, as was uneaten food. Because trained staff were available more detailed activity records were kept. This time the "average" diver had a positive energy balance, Table 1, Experiment 3. Sixty minute swimming is recorded with the diving time because one of the subjects developed ear trouble and could not dive. Rather than leave him out he swam the same distance on the surface when it would have been his dive. If both diving and swimming are counted the total time in the water was up again.

Most people were happy with the results. It had been shown that there was not a food problem so the administrators were happy. The instructors were happy because the students performed better.

TABLE 1

ENERGY BALANCE STUDIES

	EXPERIMENT 1	EXPERIMENT 2	EXPERIMENT 3
MAN DAYS	14	12	15
INTAKE	2796 KCAL	3892 KCAL	4533 KCAL
EXPENDITURE	3462 KCAL	4193 KCAL	4499 KCAL
BALANCE	-666 KCAL	-301 KCAL	134 KCAL
DIVING TIME	158 min	190 min	147 + 60 mins swimming

It is of concern that the experiment series may contain an unintentional bias. No warning was given of the first experiment, a few sailors appeared and made notes. The second time it was obvious that something was going on. Food was weighed and I was taking notes of activity and food consumption. By the time the third experiment started the catering staff knew that the quality and quantity of food was being studied. At each stage the food quality and quantity went up. For example in the first experiment food was often left on the plate. During the third experiment the divers often went back for second helpings.

It may be significant that the two divers with the most negative energy balance in the third experiment subsequently gave up diving. These divers also showed the greatest weight and body fat loss. They had no major reason for giving up so it is possible that energy deficiency caused them to lose interest.

Another problem is the energy cost of rewarming a diver. A 70 kg diver having four dives in cold water loses heat. If the heat lost is replaced by extra metabolism he uses extra energy. If the body heat content is slowly made up by conserving heat, by vasoconstriction, little extra energy is needed. Conservation was assumed in our experiments and this could result in an underestimate of energy expenditure of 600-800 Kcal. An answer to this question, or a technique for solving the problem that caused no interference to the subject, would be of great interest.

COELENTERATE STINGS

The second study was of the treatment of Portuguese man-of-war or blue bottle, stings. There are two species of coelenterates that cause significant problems in Australian waters. The box jellyfish, Chironex fleckeri, in the north has caused over 50 deaths. The Portuguese man-of-war, or blue bottle, a physalia, often causes the closure of Sydney beaches.

Until the late 1970’s methylated spirits was the most common treatment, applied liberally to the sting area. Then a group in Townsville reported that the application of methylated spirits caused box Jellyfish nematocysts to discharge. They reported that vinegar and other dilute acetic acid mixtures inhibited discharge. Their interest in the subject may have been caused by a case they reported of a woman who got no relief from methylated spirit but got drunk on the fumes.

We decided to see if vinegar was of use in treating blue bottle stings. It was compared with methylated spirit, “Stingose”, which is a commercial anti-sting preparation containing aluminium sulphate, and sea water.

Twenty “volunteers” were stung with bits of tentacle on four sites on the inner side of the fore-arms. After two minutes one site was treated with each remedy.

All the tricks required by the statisticians were followed. The subjects and observers did not know which remedy was used on each site, treatments were changed from site to site so subjects could not compare results, etc. The subjects were asked to assess pain just after treatment, and 5 and 10 minutes later. Skin reaction was assessed by an observer 5 and 10 minutes after treatment.

The results obtained are summarised in Table 2. The Unsure line indicates that the subject or observer could not decide which area had the greatest or least response.

The first and most obvious conclusion was that methylated spirits was worse than no treatment. The second was that vinegar and “Stingose” worked some of the time with vinegar marginally better. As neither gave a good response the conclusion was that local anaesthetic was needed for severe stings, which had previously been suggested by Carl Edmonds in Dangerous Marine Animals.

The response to these mild conclusions suggests that they were published on a no-news day. TV, radio and newspapers suggested we had found a wonder drug. The results justify no such claim. Methylated spirit would appear to cause more pain than salt water so one would have been better staying in the surf (provided one was not stung again). “Stingose” and vinegar have some use but do not work all the time.

Our results are of interest to two groups of people. For researchers it is an interesting area where a better answer is needed. For divers and medicos who practise near the beach, the message is try vinegar but have your local anaesthetic handy.

TABLE 2

BLUEBOTTLE TENTACLE STINGS
ASSESSMENT OF PAIN AND SKIN REACTION

TREATMENT	MOST PAIN	MOST RELIEF	MOST SKIN REACTION	LEAST SKIN REACTION
Vinegar	7	25	1	17
Stingose	4	19	6	10
Methylated Spirits	27	1	17	2
Salt water	19	9	12	4
Unsure	1	6	4	7

Question.

How did you calculate the energy expended in the first study?

John Pennefather.

There are books of tables of energy intakes and expenditure. For most activities we used these tables. For the oxygen diving time we could calculate the energy used as we know how much oxygen the set receives each minute and the divers swim along using just that amount of oxygen.

Question.

So really it was not very accurate?

John Pennefather.

No, but that is the way every nutritionist does it. They use the tables and make no allowances for changes in temperature, which surprised me. I have had very little nutrition training, and I always believed the figures.

Question.

Did you follow the body weight of the divers? That is the best indicator of their imbalance, providing they have adequate food.

John Pennefather.

Over six months quite often these people will lose three or four kilos, but in some cases it is an obvious loss of fat. The ones that I am worried about are the thin ones. I said two had dropped out, they were fairly scrawny people at the beginning, they became more scrawny, and they eventually gave up, without giving any reasons, they just said "It is not for us." I think they are the people that we might be losing. What we could do next is to follow skin fold thickness and bodyweight.

TESTING SURVIVAL SUITS
ARE THEY GOOD ENOUGH?

Arvid Påsche & Susan Gordon

In 1982 the Norwegian Underwater Technology Center evaluated the thermal insulating properties of a number of survival suits, such as are routinely worn by all personnel during helicopter transport offshore. The purpose of the suits is to keep their wearers afloat, dry and reasonably warm in the event of a crash-landing in the sea. Hypothermia is recognised as the major danger for survivors of helicopter crashes.

The purpose of the study, which was to be as realistic as possible, was to highlight the practical aspects of using various makes of suit, and provide a clearer picture of each suit's advantages and drawbacks. The study was funded by Statoil, and was fully described in NUTEC Report 43-82.

There were three parts to the testing routine:

1. Evacuation: evaluation of suits during evacuation of a sinking helicopter; determination of water leakage in the suit during evacuation.
2. Buoyancy: determination of total buoyancy for a person dressed in a survival suit.
3. Thermal insulation: evaluation of the insulative properties of suits after evacuation.

Part 1, Evacuation, was carried out at the Offshore Survival Centre in Aberdeen, where a "helicopter underwater escape trainer" enables personnel to be trained in evacuation procedures. These tests showed that the chances of water entering a suit during evacuation is fairly high, even if the suit is zipped up and the hood is worn. Between nine and ten kilos of water can enter a suit which is not fully zipped up.

The buoyancy tests were performed in the pool at NUTEC, using a specially weighted chair equipped with a safety belt to simulate a helicopter seat. The chair could be turned so that the subject would find himself sitting in a head-down with closed (A) or open (C) zippers, or head-up (B) position underwater (for results, see Table I). Some of the suits had buoyancies as high as 40 or 50 kp. It is unlikely that many people would have the strength and training necessary to force themselves down and out of an upturned helicopter if they were carrying so much buoyancy.

TABLE I

Suit		Buoyancy A	B	C
HELLY HANSEN E353	Mean:	41.7	19.38	14.35
AQUA SUIT	Mean:	26.15	15.33	13.42
MUSK OX	Mean:	10.67	8.3	13.42
NORD 15	Mean:	39.53	18.7	12.23
MULTIFAB	Mean:	16.8	12.10	7.8
IMPERIAL "H"	Mean:	20.5	12.2	10.45
PIONER/LIUKKO "COMBIE"		46.5	27.4	17.5
PIONER/LIUKKO "PILOT"		31.4	27.4	10.0

The thermal tests were also carried out in NUTEC's indoor pool, which was filled with seawater at a temperature of 9-11°C. With air temperatures as high as 15°C and no windchill factor, the test did not attempt to reproduce "worst case" conditions. All subjects wore a cotton jacket and trousers under the suits, and in some cases (see Table II), woollen underwear as well.

Both wet and dry tests were run. In the wet tests, subjects let 12 - 13 kg cold seawater into the suit by immersing with a partially open zipper, much as might happen in a real-life emergency. Then they lay quietly in the water for a maximum of two hours. Tests were terminated early if a subject's rectal temperature dropped to 35.5°C or if he felt too cold and uncomfortable to continue. Rectal temperatures were used to calculate average cooling rates, which are presented in Table II.