Now the diver can enter the water and perform his tasks. Training includes diver rescue, which is difficult through the narrow Comex hatches. At the end of the exercise the diver returns to the "bell". The inside door (No. 5 in Figure 1) of the trunking is shut and the "bell" is slightly over pressurised to seal the hatch. Now the higher pressure in the bell keeps it shut. At sea the bell would now be hoisted aboard and the divers transferred to the chamber either to be decompressed or to be held in saturation. The same routine is undertaken in the simulator, the only difference being that there is no mating of the bell to the chamber as that link has never been undone. Nevertheless those in the simulator have to go through the same routine of having the chamber pressurised and then the trunking, joining chamber and bell, pressurised before they can open the bell and crawl through into the chamber.

The UTC hopes to obtain another small chamber to mate to the entrance lock of the large chamber, with a hatch capable of accepting the bayonet fitting of a Dräger Duocom portable 2 man chamber. The NSCA runs a hyperbaric emergency service based on Morwell using Dräger Duocoms as the portable collecting chamber with the patient being decanted into a larger chamber at Morwell. However this chamber is limited to 50 m which might not be deep enough to give relief of symptoms. At present the patient cannot be transferred under pressure to the UTC chamber. An extra chamber, with a flange accepting a Duocom, on the UTC system would allow for such transfer.

Since this paper was presented the UTC has obtained the extra chamber mentioned in the last paragraph.

NEUROLOGICAL CONSIDERATIONS IN DIVING

David Brownbill

At the outset I wish to acknowledge the work that has been done in the field of fitness to dive with neurological conditions by John Hallenbeck and Hugh Greer who are both neurologists and divers and have been very closely associated with the United States Navy.

Any discussion on neurological conditions in diving must consider the neurological conditions that can result from diving and, probably more important to us here, advice to divers for their future activities when they have a pre-existing neurological condition or one that develops as a result of diving. Pre-existing neurological conditions fall broadly into three groups, head injuries, people who have undergone intra-cranial surgery for whatever cause, and those who have unrelated medical neurological conditions. The important problems are epilepsy, the changes that may occur to personality, which I will discuss later, and damage or impairment to the special senses of vision, hearing and balance.

There are two relevant statistical factors about epilepsy. The first being that 5% of the population will at some stage have an epileptic fit of some sort, for example as a youngster with a fever and secondly that 0.5% of the population will actually be termed epileptic, having recurrent fits requiring medication. The whole point about epilepsy is that it involves a low threshold to cerebral discharges. As a result of that low threshold precipitating factors may cause discharges that will result in that which we know as clinical epilepsy. The factors which are significant in diving include cold, decreased oxygen levels, or more importantly raised oxygen levels, decreased carbon dioxide which occurs with hyperventilation, hunger, alcohol and scarring of the brain. Here we might talk about the person who has undergone a craniotomy, surgery for let us say a meningioma. If it is in the posterior fossa and if there is no balance disturbance it is of no significance. However, if the surgery has involved the supratentorial region it carries, in the normal population without diving or the attendant precipitating factors, a chance of post surgical epilepsy approaching 10%. That raises the question of the incidence of epilepsy that one may expect in a person, following such surgery, who is diving and is therefore exposed to these precipitating factors. Epilepsy itself may occur with or without loss of consciousness. It may be just a momentary loss of awareness, but it does always interfere with the control of behaviour and performance and it does always occur without warning. There may be an aura that it may occur but the actual moment of occurrence is without warning. As I said before, in diving, vital considerations involve carbon dioxide or oxygen blood level changes which often happen and which may act as a precipitating factor in a person who already has a lowered threshold.

What advice should be given to somebody regarding diving who has suffered an epileptic fit? Now the first, and I think non-discussable, situation is if they have uncontrolled epilepsy, that is, they have epileptic seizures and are on medication. Without discussion I would say, not only should they not dive, they MUST NOT dive, full stop. The next question is regarding the person who has well controlled epilepsy, that is the person who has been on medication and has been seizure free for two years. Here we have to consider that such medication may make people drowsy and under increased ambient pressure these effects may be increased. Such persons have, of necessity, a remarkably reduced threshold to epileptic discharges which makes them more susceptible to precipitating factors. They should also be advised not to dive. The more controversial area is the one of, so called, arrested epilepsy, the person who has been five years free of epilepsy and has not been on medication. The current wisdom is that they be advised to avoid incidents where the oxygen pressure may increase, to avoid hyperventilation, to take care of currents, cold and stress. In other words they are to dive perfectly and never encounter any problems. I differ from the current wisdom and believe that anybody who has suffered an epileptic seizure should not dive. This advice is mandatory if they have uncontrolled epilepsy. In the other groups they make the decision but my advice is that they should not dive.

Personality was mentioned before and although this is not strictly a neurological consideration it does come into play, for example, following head injuries, cranial surgery or any form of cerebral insult. All of these may alter the personality but experience has shown that they accentuate a pre-morbid personality. Very rarely do these insults

make a gentle person aggressive or the other way round. What does tend to happen is that the person's personality traits are highlighted. When this is being looked at one must consider tendencies to aggression or tendencies to schizoid behaviour which may well be accentuated by a past cerebral insult. The changes may affect logical actions under stress, or they may affect the ability to make decisions, for example in dive planning. This is a small but significant consideration.

The next question relates to the diver who has suffered a past decompression insult to the central nervous tissue, either within the head or within the spinal cord. This may include recovered paraplegia or damage to the special senses or involve motor sensory impairment, or loss of consciousness. What advice should be given to the person who clinically has made a complete recovery?

To take the first example, the one who has a recovered paraplegia, a so-called "spinal hit". They lose bladder and bowel control, may have total sensory and motor disturbance and recover with appropriate treatment. If they make a recovery they tend to make a very good one and it may, to all intents and purposes, be complete. I am going to use this as an example of central nervous tissue damage because there are several well recorded cases of such people who have died for unassociated reasons and have come to post-mortem. Sections of the spinal cord have shown quite clearly marked pathological changes of sclerosis and fibrosis of tissue indicating areas of neuronal death that have not had the expected clinical manifestations. Experimentally it has been known for a long time that central nervous tissue that is damaged from whatever cause has scar tissue that is more susceptible to decompression illness than areas that are not involved. Once can be certain that the person who has a completely recovered paraplegia from decompression sickness has marked damage throughout the spinal cord and the advice I would give under these circumstances is that they should not dive, and by extrapolation, I believe people who have had a decompressive insult to the central nervous tissue, that is they have suffered sensory motor disturbance or loss of consciousness, or special sense impairment which would be reasonably believed to have resulted from a bubble, should not dive. There should be no further diving by those exhibiting an incomplete recovery. But there appears to be no reason why the person who has complete paraplegia following trauma should not dive. In fact many have been taught to dive and as long as it is done by experienced teachers, as there are problems with buoyancy, balance, propulsion and problems that occur with distribution of fluids within the body because of the loss of vaso-motor control, I place no bar at all on them diving.

Migraine is, in itself, not disqualifying unless it is severe and frequent. What the person and their diving companions must realise is that if they do suffer a severe migraine attack on returning to the vessel this can cause confusion with symptoms that would arise from an unassociated decompression sickness and therefore one may well be placed in a situation of having a migraine attack treated by recompression. If in doubt that course is by far and away the safer as it does not do any harm to the migraine.

When discussing head injuries one must consider dural penetration by a spicule of bone or early post-traumatic fitting, as in each of these situations there is, unrelated to diving, a greater than 30% chance that at some stage a late post-traumatic fit will occur. That means they have a markedly reduced threshold to electrical discharges and that means they are much more susceptible to the precipitating factors that may result from diving. Of all the people who develop late post-traumatic epilepsy from a head injury, more than a quarter of them have their first fit more than four years following the accident. Looking at people following a head injury, who have suffered an early fit, or a dural penetration, nearly 10% of them will commence fitting after four years and that, of course, has great bearing on the advice one must give them as to the risk they run if they dive.

A valuable yard stick to use in advising people following head injuries is the United States Air Force (USAF) guidelines for evaluation of fitness to fly. For convenience head injuries are divided into four groups from severe to very mild.

The permanently disqualifying conditions are contusional laceration of the brain or an immediate post head injury fit. These two are absolutely disqualifying conditions. The USAF guidelines also include as permanently disqualifying conditions those who have had a head injury with a loss of consciousness of more than 24 hours.

Conditions that will disqualify for two years after injury include unconsciousness for greater than two hours or a post-traumatic amnesia greater than 48 hours or a post-concussive syndrome of sleep disturbance, personality disturbance, headaches or memory disturbance for more than a month. It should be noted that there is no worthwhile correlation between electroencephalographic findings and any prediction of late post-traumatic fitting. The results of such investigations really bear little relation to the decision as to whether someone should dive or not.

The person who is unconscious for 15 minutes or more is not allowed to fly in the USAF for three months. I see no practical or theoretical consideration to regard that any differently from the advice we give to someone who is going to dive.

The last group is of those who should be disqualified from diving for four weeks. This has implications to those of us who look after the younger age group, for example footballers who suffer head injury with unconsciousness that lasts for less than fifteen minutes. This is a mild head injury and yet involves a low threshold to epilepsy, low threshold to personality changes and perhaps decreased reflex reactions under stress. I support, in diving, very much the view of the USAF and would recommend advising anyone with a mild head injury against diving for four weeks.

For commercial diving any central nervous tissue abnormality or doubt of the integrity of the nervous tissue functioning should preclude diving. For the rest of us diving is fun, and there are other sports that can be chased without putting oneself or ones buddies at risk. I do not think central nervous tissue damage, with the few exceptions mentioned, is really compatible with safe diving.

Surgeon Captain RR Pearson

One of the things we have been trying to get a grip on in the Royal Navy and things about which we have had conflicting advice is the relative significance of pre-traumatic amnesia and post traumatic amnesia.

Dr D Brownbill

The two forms of amnesia are those for events before the accident (pre-traumatic) and those for events after the accident (post-traumatic). The one that has a very close correlation with the severity of the head injury is the post-traumatic amnesia. In nearly all instances pre-traumatic amnesia or retrograde amnesia is short even for very severe head injuries. It is occasionally long but when it is long it does not correlate at all well with the severity of the head injury but the post-traumatic amnesia does. Indeed in medico-legal circles experience has lead me to believe that when somebody with a moderate head injury has a retrograde amnesia extending six hours, it is often with the intent of trying not to remember certain aspects.

Question:
What raised levels of oxygen can precipitate epileptic fits?

Dr D Brownbill

The generally accepted figure is that of two atmospheres of inspired oxygen. It would be most unusual if it occurred below a level of 150 mm of mercury of oxygen in the blood. In a person with a low threshold to epileptic discharges if the partial pressure of oxygen in the blood drops below about 80 mm of mercury this may precipitate a fit.

Question:
What about leakage of cerebro-spinal fluid following a head injury? Should these people dive?

Dr D Brownbill

If CSF rhinorrhoea or otorrhoea is proven (and the only accurate way to do this is by specialised dynamic CSF radiological tests) the person should not dive. As with a lot of assessment of fitness for diving, if there is a reasonable doubt that someone has a cerebro-spinal fluid leak they should be advised not to dive. It may be said that this would apply only until they had a craniotomy and repair of a dural defect. But that operation will entail a risk, of about 10%, of post-surgical epilepsy occurring. That in itself, would suggest that diving should not be continued.

Question:
What about a person who has suffered an isolated fever convulsion as a child?

Dr D Brownbill

Such a convulsion fits into the group previously discussed of 5% of the population who suffer an isolated seizure. Clearly one cannot be too dogmatic in this situation. I would be prepared to allow such a person to dive but I would think it right and proper that diving companions should be informed that this person has an increased risk of having a fit.

The reasons people may die when they have a fit underwater involve some things I did not bring up before. What to do if your buddy is having a fit? He has a risk of dying for two reasons. One is that he loses his mouthpiece and drowns. If he does have a fit and is lucky and his mouthpiece is held in position then he will not drown unless he bites through it. If one is close enough and can hold the mouthpiece in position very good, but here is where a certain amount of self-control is needed. The first thought will be "Get him up quickly" but one must not do this, as the second reason such people may die is because in the early stages of a fit they are breath holding. With glottic spasm such a person runs a very good chance of rupturing the lung and receiving an air embolus if they are brought to the surface. Therefore what one should try to do is hold the mouthpiece in until respiratory activity returns and then take the diver, who may still be unconscious to the surface with his head held extended to allow passive exhalation. The period one may have to wait may seem an eternity but it is, in fact, only between 20 or 40 seconds. There are, of course, apparent risks in waiting with such a person before coming to the surface but on the balance of risks I would regard waiting as the safer procedure.

Question:
Should people who are involved in sports such as boxing, where they receive regular mild head injuries, be allowed to dive?

Dr D Brownbill

If these people have not suffered a fit or a significant head injury, I do not think we can be dogmatic about the advice given. We know they are receiving regular cerebral damage but we do not know if they have scars sufficient to increase an epilepsy tendency. One would try to ascertain the number of occasions of loss of consciousness, for example, and the periods of such loss and try to explain to the individual the increased risks that would be run, for example if they encountered a change in oxygen or carbon dioxide levels, and the decision to dive would remain with them.

Question:
People with disabilities such as epilepsy are mostly determined not to be seen as different from other members of the community and may not wish to have their right to dive taken away because of that affliction. Do you not think that because of their wish to participate fully in the community many epileptics should be allowed to dive?

Dr D Brownbill

Actually unless they have suffered repeated cerebral damage from anoxia resulting in aggressiveness and loss of normal thought processes most people who suffer from epilepsy are responsible people who are amenable to logical discussion. If they were told they should not dive because they may drown or they should not drive a car because they may kill themselves they might reasonably say that they are prepared to accept that risk. However, if in discussion one points out such fitting may endanger the lives of their buddies or other people on the roads, my

experience suggests that they will readily accept such advice. I agree that it is hard to find a case where a person suffering an epileptic seizure underwater has resulted in a death but I would regard it as impractical to suggest that someone who is on medication for epilepsy be allowed to dive.

Question:
Diabetics may sometimes have changes in conscious level. Should they be allowed to dive?

Dr D Brownbill

A discussion on the management of diabetes is perhaps not appropriate here but it is worth commenting on the prospects of a diabetic suffering a hypoglycaemic attack whilst diving. Such a person who has decided to dive should take precautions by omitting their normal dose of insulin beforehand and they should take some sugar beforehand and even carry a little plastic bag with some sweets whilst diving because they will have warning of an impending attack and they will have learnt to recognise such warnings very quickly. The careful and experienced diabetic, with appropriate advice, should therefore be able to dive but again his buddy should be aware of the problems.

Dr David Brownbill is the Senior Neurosurgeon at the Royal Melbourne Hospital.

A CASE REPORT - SEA SNAKE BITE

Chris Acott

I do not wish to repeat myself and give another talk on sea snake envenomation, however we had another sea snake bite late last year.

A 19 year old youth was swimming in some murky water when he thought he saw a stick on the bottom. He dived down and picked it up. The stick turned around and bit him on his forearm in two places. One bite was at the wrist and the other on the upper aspect of his forearm.

First aid measures were applied immediately, and he was brought into hospital. When the crepe bandage was removed there were no signs of envenomation. He had first degree heart block on his ECG, and I began to rub my hands with glee that it might have been caused by the venom, but disappointingly it turned out to be congenital.

This was the third sea snake bite that has come to the Rockhampton Base Hospital in the past three years. Only a little girl required treatment for envenomation. This agrees with Reid's original work which said that only a one-third of cases show signs of envenomation.

The girl was bitten on the foot, again the snake meant business. Again Reid's work was verified as she showed signs of a massive envenomation. The symptoms occurred within 2 hours (Reid's 2 hour rule) and required 8,000 units of the antivenom.

Reid divided his cases of sea snake envenomation into 'serious' and 'non-serious' by his 2 hour rule. Serious envenomation was indicated by myalgic pains especially of the neck muscles, trismus, ptosis, ophthalmoplegia, myoglobinuria and a leucocytosis of greater than 20,000, all occurring within 2 hours, if no first aid measures had been applied. Serious cases required up to 10,000 units of the antivenom, while the non-serious required only about 3,000 units.

Sea snake venoms are either neurotoxic or myotoxic or a combination of both. The neurotoxic venom acts either pre- or post-synaptically or with a combination of both. The myotoxic venom causes muscle destruction with myoglobinuria and myoglobinanaemia which may lead to renal failure.

One should use either sea snake antivenom or Tiger snake antivenom. As a last resort poly-valent antivenom can be used.

SPUMS NOTICES

OBJECTS OF THE SOCIETY

To promote and facilitate the study of all aspects of underwater and hyperbaric medicine.
To provide information on underwater and hyperbaric medicine
To publish a journal.
To convene members of the Society annually at a scientific conference.

MEMBERSHIP OF SPUMS

Membership is open to medical practitioners and those engaged in research in underwater medicine and related subjects. Associate membership is open to all those, who are not medical practitioners, who are interested in the aims of the society.

The subscription for Full Members is $30.00 and for Associate Members is $20.00.

Membership entitles attendance at the Annual Scientific Conferences and receipt of the Journal.

Anyone interested in joining SPUMS should write to:

Dr Chris Acott,
Secretary of SPUMS,
Rockhampton Base Hospital,
Rockhampton QLD 4700.

NOTES TO CORRESPONDENTS AND AUTHORS

Please type all correspondence, in double spacing and only on one side of the paper, and be certain to give your name and address even though they may not be for publication.

Authors are requested to be considerate of the limited facilities for the redrawing of tables, graphs or illustrations and should provide them in a presentation suitable for photo-reduction direct. Books, journals, notices for symposia etc., will be given consideration for notice in this journal.