

frighten abalone divers, from the

long range point of view. They are concerned as to whether or not their repetitive dives over the years will produce a defect in or around a joint.

The abalone divers on the Far South Coast of New South Wales are far more educated than they were in the past, and they are far more sensible. Most of them are aged between 30 and 45, they have wives and children, and they take a much greater interest in their own welfare, and in the welfare of their fellow divers.

I have had one diver recently, who went through quite a lot of stress, because he had been involved in the re-organisation of the abalone industry in New South Wales, and he had been subjected to perhaps unfair harassment, verbally and in other ways. He was diagnosed as having a stress problem, he was treated with lithium, and later he displayed quite a lot of intermittent aggressive behaviour, 'smashing up dishes and throwing furniture around, and finally crashing cars and wrecking boats. There was some doubt as to whether or not this behaviour was related to the lithium. I am interested to know whether lithium is a safe drug for divers.

DISCUSSION

Dr Carl Edmonds

Lithium has been used at depths of 1500 ft, without showing any serious effects. I would not worry about the effects of that drug under pressure at all. However, one would question whether or not lithium was the appropriate treatment for the particular medical condition afflicting that diver.

The business of divers smashing things up is very common, especially after a dive. In fact, in some other areas, such as Port Lincoln, where abalone divers are more wealthy, and as wealthy people tend to look after their property, there is one diver there who has an old car, which he goes and smashes up whenever he feels aggressive! Aggression is something that has been commonly recorded in abalone divers.

Dr Janine Mannerheim

I have a patient who has been diving for twenty years. He has been taking lithium for about six years, and he dives 200 to 300 times a year, averaging between 24 and 39 metres, and it does not seem to have made any difference to his behaviour.

Dr Peter McCartney

You mentioned that the abalone divers in your part of the world tend to collect their catch, and ascend after a long session. I have often raised this with the Tasmanian abalone divers, and to my knowledge, only two of them do that. They have developed a little rig, with snap hooks, and this allows the catch to ascend on the hookah line, although this is not an ideal thing to do. The common practice is for these divers to ascend and descend, with fairly small loads. I think this is a very dangerous practice. I have been trying unsuccessfully to get them to convert to only making a minimum number of excursions to the surface.

Dr John McKee

In our area I think there are possibly more ascents and descents, than there used to be, perhaps five years ago.

Since then abalone are being bought on the shell, so there is no need for a sheller always to be aboard the boat. The sheller was often very useful if there were changes in the weather, or the Fisheries Inspector arrived, etc., etc. Since the sheller has been done away with on many of the local bats, this is a major reason for more ascents than in the past.

Dr Peter McCartney

Our divers are specifically prohibited from shelling on the boats, and that is an official Fisheries Inspector's ruling, to 'which they seem to adhere.

THE PUNCHDRUNK DIVER

Carl Edmonds

Unlike my other lectures, I have found this presentation to be particularly difficult. I am going to try and give an overview of this history of the problem, and a statement regarding our current position.

Some years ago, a group of divers asked me if there was any truth in the common belief of "divers' dumbness". Because I was not aware of any such problem, and because I had previously demonstrated that intelligence is positively correlated with success in diving courses, I had no compunction about reassuring them.

Unfortunately, the problem did not go away. More references to the "punchdrunk diver" and to the "tunnel-brain caisson worker" made me question again the possibility of brain damage associated with excessive diving exposure. Indeed, I began to believe that the reassurances I had given may only have served to conceal my ignorance.

About the same time, a group of navy wives contacted the Royal Navy Physiological Laboratory, complaining that their husbands had appeared to suffer from a variety of disorders associated with their saturation diving. Of the seven husbands (divers) concerned, six appeared to have an atypical or sensitive response to alcohol, five showed aggressive behaviour and short temper, four had an inability to concentrate, tiredness, short memory, visual problems and a disinterest in appearance. Three were said to be secretive, slow and anxious, two had an inability to communicate, and one had become antisocial.

This type of anecdotal information is very difficult to evaluate. Certainly, the same type of things had been said amongst the wives of our own professional abalone divers, many of them stating that the husbands were very irritable, aggressive, non-communicative and inconsiderate following their diving day. The director of one of our major abalone co-operatives has stated that he would not consider contacting the diver after his day's work, even to transmit good news. "Phone him up that day, and you get into a fight, phone him up the next day and he is very reasonable".

Literature

It is not difficult to summarise the literature on this subject. There is not much of any great note. In one series of papers, it appeared as if divers who suffer severe neurological decompression sickness are likely to become effected to some degree.

Rozsahegi, in 1959, from the Hungarian Institute of Industrial Medicine, examined 100 subjects between two and a

half and five years after they had developed neurological decompression sickness and over half were said to have had some form of neuropsychological disorder. He pointed out that three quarters of these patients had evidence of neurological disease on clinical examination. He also noted that, often quiet men would become irritable and uncontrolled after the injury. Pathological drunkenness and alcohol intolerance were also frequent.

From Hawaii, Peters, Kelly and Levine, showed neurological and psychological problems following decompression sickness affecting the central nervous system. Of the ten cases, two had no neurological deficits, and eight had evidence of such damage. Unfortunately, all patients had litigation proceedings underway, and this may have influenced the psychological assessments.

Beirsner and Ryan showed a psychiatric incidence rate in the US navy divers, of twice that of the normal diving control group.

Vaernes and Eidsvik in 1982 in Norway, showed neurological damage after diving accidents, related often to cerebral gas embolism or hypoxia. Eight out of the nine divers showed some abnormalities on a barrage of neuropsychological tests, and five of them had specific memory defects.

In a symposium held on the long term neurological consequences of deep diving in 1983, at Stavanger, Norway, it became clear that many attendees believed that the long term neurological abnormalities were absent, rare or transient. In fact, the question is now enmeshed in the problems of litigation in the USA, and it has almost become a matter of which expert you wish to buy, to prove your position on this subject.

At the Stavanger symposium, there had been apparent acceptance of the neuropsychological complications of diving with compressed air at shallow depths, even though it appeared no consensus was reached regarding the deeper diving, and the complications of that.

Even though it is obvious that brain damage could result from neurological decompression sickness, it does not follow that the average or even the extensive professional diver has a significantly increased likelihood of this problem developing. Comex representatives claimed that, after 13,000 professional dives and 3,000 saturation dives, they were adamant that there was no neurological or neuropsychological complications. It appears as if the administrators at the deep diving unit at Duke University also have the same approach.

Dementia

Permanent brain damage leading to a deterioration of intellectual capacity is described as dementia. To demonstrate that dementia has developed, it is necessary to measure the degree of deterioration in intelligence.

This requires a knowledge of intelligence and its measurement. I shall explain some of these tests later, but at this stage, I would like to dispense with some popular misconceptions. Some think that, because a diver is young, he will be able to overcome minimal brain damage. Unfortunately, the opposite is probably the case. Regeneration does not develop in the central nervous system. It may well be that he can reorganise his current functions and abilities to give the appearance of improvement, but the tissue which has been irreparably damaged, will not regenerate.

Another belief is that, if you have had brain damage and get over it, you are then all right. Unfortunately, such is not the case. We all have a certain potential of intelligence, an innate ability, and once a part of the brain has been damaged, and the potential diminished, this is going to show up with increasing age. If you lose intellectual potential at a young age, then you are closer to the threshold at which the subsequent brain damage, dementia, or senility, will occur.

A characteristic of brain damage is the "drop and rise" effect. There is an immediate impairment of intellectual function which will appear to improve as time goes by. It may take half to two years before the subject is apparently normal. Even when he is back to his apparent normality, he is then much closer to the threshold at which dementia can and will occur in the future. In fact, it has been estimated that about 50 ml of brain tissue needs to be destroyed before the threshold is reached. Whether brain is destroyed by decompression sickness, carbon dioxide toxicity, hypoxia, arterial disease or age the results are summated.

The measurement of intelligence

There is no direct measurement of this faculty. Some cynics have suggested that "intelligence is what intelligence tests measure". This somewhat cyclical argument is meant to avoid the definition of intelligence.

There are a variety of acceptable ways in which brain function can be measured. Apart from a good history and clinical examination, a variety of electrophysiological tests are available. These include the electroencephalogram, evoked cortical potentials involving visual and/or auditory stimuli, somatosensory evoked cortical potentials, etc. These may often reflect the dysfunction of both peripheral and central sensory functions as well as the ascending reticular activation systems.

A variety of other neurophysiological tests can be given, including the fusion of flicker frequency, reaction time and complex interactions between learning curves and reaction times.

Other clinical investigations are also possible, including such established procedures as angiograms, pneumoencephalograms, CAT scans, NMI and PET investigations.

Perhaps the most established method of assessing intellectual deterioration is to use the intelligence tests. These are very highly standardised investigations, and they will often measure different aspects of intelligence. Probably most of you remember the WAIS. This is an internationally established test which will allow testing of specific intellectual functions.

Some aspects of intellectual function are better preserved than others, following injury. Verbal fluency is likely to be retained, long after the ability to perform new functions has dropped. If you were to become demented at the age of 30, then the words that you had learnt would remain with you fairly well. Only when you become very senile, will you actually forget those words. In lesser degrees of dementia, the verbal fluency is retained. That is why old people talk so well, they can outtalk the younger ones. Their verbal fluency is still good, but their ability to handle new information is not.

We can thus say that their conceptual ability or their intel-

lectual performance in handling new problems is impaired, but their verbal intelligence is unimpaired. These things are comparable, so that if one looks at the WAIS and finds that, the verbal intelligence and the performance intelligence is about the same, then that intellectual deterioration is unlikely. If, however, verbal intelligence is 140 and the performance is 100, then that infers a dementia with a loss of approximately 40 IQ points. This is a gross over-simplification, but it demonstrates the concept of comparing different sorts of intelligence.

In fact there are a variety of sub-tests for Intelligence, and if enough of these tests are done, then one can obtain a profile of the intelligence. Different profiles may well be consistent with different types of injury, eg. carbon monoxide poisoning, hypoxia, etc. Unfortunately, we are not aware of the type of profile that would be consistent with multiple cerebral arterial gas embolism or decompression sickness.

The number of neuropsychological tests have increased in sophistication, and require trained administrators to perform them.

CURRENT INVESTIGATIONS

Background

We decided to look at a different population from those previously studied by others. In Australia, litigation is not a terribly important point. Most of the extensive divers are those involved in the abalone industry and these are self-employed people to whom compensation is not a factor.

Also, the question being considered was not whether a severe neurological decompression sickness could produce brain damage. The question was whether long term diving is likely to result in this problem, without a gross neurological decompression sickness incident.

The Studied Population

Because we wished to find out whether diving produces intellectual impairment, we decided to study not the average diver, but the type of diver who would be most likely to be affected by a diving related illness, ie. one who performs an enormous amount of diving. The rationale behind this was that of the Null hypothesis.

By selecting the most extreme of the diving groups, we could reasonably conclude that, if the investigations showed no significant abnormality, then it is unlikely to be a major problem amongst the lesser exposed diver.

I was aware of Rozsahegi's similar concern for his caisson workers, but I must admit to believing that his data was not applicable to our divers. Perhaps I was too rash in this judgement, and I should also have made more allowance for the complexities of the problem. Nevertheless, I decided to look into this more closely when the opportunity arose. Now that I am no longer in full time practice, or have to fight for research approvals, I can follow up these whims.

"Chance favours the prepared mind" (Pasteur). Within a few months, Chris Lowry and I headed off to Twofold Bay, at Eden, to test out some of our hypotheses on a very special diving group. One hypothesis was: if this group showed no evidence of dementia, with the enormous diving exposure they had, and with their flagrant disregard for decompression requirements and safety aspects, then dementia was not likely to be a widespread complication of diving.

In New South Wales, Australia, abalone divers are a closed community. They were obliged to register for licences in 1980, and a prerequisite was to have had three years full time professional abalone diving prior to that. Thus the minimum duration of diving was six years, without any formal training being required. They tended to be ex-fishermen, from small fishing families, who had moved from their previously profitable and traditional occupation to the more lucrative abalone industry, taking with them their maritime skills, but little else.

The diving was strenuous, with the divers carrying bags of abalone and enduring the tidal drag on their long hoses, for most of the dive. Each diver would average approximately 100 days diving per year and in each diving day, he would be underwater for a total of four hours, and this was unrelated in any way to his depth. The average depth would be about 60 feet and the surface intervals vary from ten minutes to one hour, being the time required to move his boat to another area. No decompression staging was performed.

Results

Of the 31 divers who were tested, 6 had to be removed for technical reasons. Of the remaining 25, 12 showed no evidence of intellectual impairment whatsoever compared to their previous status, and adjusted for age. In one case the results were questionable. In the remaining 11, there was evidence to support the possibility of dementia.

Obtaining the co-operation from such an independent group was not easy. Chris and I gave some lectures, especially tailored for these divers and their type of diving. We socialised with them, windsurfed with them and finally we dived with them (but we decompressed along conventional lines). We gained their full co-operation when we admitted our ignorance regarding many of the questions related to the diving industry, eg. personality profile of people who were more likely to be successful divers, people such as themselves. With a little praise and some soft talking, they agreed to assist us by undergoing some of our tests.

Present Study

Because of the Eden data, there was no alternative other than doing a full scale investigation encompassing many of the neurological and electrophysiological tests referred to earlier, and combining them with a much larger battery of neuropsychological tests performed by experts in each area.

This is where we are at the moment. We are carrying out a great number of neurological investigations including EEG, CAT scan, neurophysiological tests such as fusion of flicker frequency, and the Sternberg reaction time investigations. We are also performing a whole battery of psychological tests, both on divers and controls, to clarify the findings referred to above.

As a separate but integral part of the investigations, we are also testing subjects who have recently been affected by decompression sickness (neurological type) and decompression sickness (non-neurological type). The data is pouring in, and the little computer is running hot.

Different skills are represented in the survey, to ensure that there is no consistent bias. Neuropsychologists, behavioural psychologists, neurologists, psychiatrists, electrodiagnosticians and diving physicians have all had an input, both in design and in the assessment of the abalone divers from most states of Australia, and the amateur divers

who have required recompression therapy from the Royal Australian Navy School of Underwater Medicine.

Comparing the results of these groups and correlating the findings with the degree and type of diving exposure, should allow us to draw conclusions about the possible relationship of diving with dementia.

MORE ON THE SPONGE DIVERS OF KALYMNOS

John Hayman

Kalymnos is a small island measuring approximately 30 km by 15 km in the eastern Aegean, very close to the shore of Turkey. Is roughly comma shaped, the comma being inverted and very mountainous and barren. The only commerce that exists, exists because of the excellent port facilities which are available on the island. There is very little agriculture apart from a few citrus trees; most of the place consists of rock. The population is about 15,000 of which 14,000 are in the port of Kalymnos, which is in the south side of the island.

The island is very close to the island of Kos, which is quite famous because of its association with Hippocrates. You can get to Kos very easily, it has an international airport and there are regular flights from Athens, as well as international flights from various places in Europe. From Kos you travel to Kalymnos by ferry and there are two or three ferries each day as well as other ferries which travel to other islands in the Aegean.

Kalymnos is the home of sponges and these sponges are sold throughout Greece. They are sold throughout the world and virtually every natural sponge that is sold has made its way through Kalymnos. Sponges have a long history and have been part of human civilisation for many centuries. They were used in Roman times as padding for armour and even before Roman times they were used as contraceptive devices. They certainly are a very versatile material. The Kalymnians have gathered sponges for centuries. Originally they collected sponges from boats where they could hook them directly from the water. They could look through glass and with a long boat hook, pull them in. As time went on the sponges became less numerous and they had to go deeper and further afield. Nowadays, the sponge fleet does most of its sponge gathering off the coast of Libya. There are several small fleets which operate from the harbour and they are not all away at the same time. The sponge season lasts about 6 months and during that time, the five or six fleets are away for about 3 months at a time, some coming back and then going out again, and some staying away for the whole six month period.

Near the harbour there is a small sponge factory close to the church. The sponges are laid out on the wharf to dry. The harbour is also used for fishing and most of the boats there when we were there were fishing boats. Most of the sponge

gatherers were at sea and only the veterans remained. There is a rather stylised statue of a diver in the square immediately adjacent to the harbour. Most of the population live in that tiny portion of the island and most of the population, if they are not looking after the tourists, are concerned with the sponge trade or the fishing trade.

As well as the main port of Kalymnos, there is a smaller port around on the eastern side, called Vathis. This is a very much smaller port, with very clear water, suitable for diving but there are no air filling facilities on the island. You can snorkel with some success in the little estuary there. There are the remains of an Italian merchant vessel which was sunk by the RAF at the opening stage of WWII.

On the other side of the island, on the western side, there is the island of Telentos. It consists of a large rocky pinnacle with the little town at the bottom. Telentos is separated from the small settlement of Massouri on the west coast of the main island by the narrow straits of Telentos. It is reputed that there is the sunken city of Telentos in the channel between the two islands. It is quite a deep channel, I had a look for the sunken city without success. My efforts were rather derided by the locals in Telentos. I was assured it does exist. There is a little ferry which goes between the two islands, it shuttles backwards and forwards about once every 20 minutes and the fare is \$1.00. The small village of Telentos is very attractive. As well as the main village, there are the ruins of other settlements on the island which date back before Roman times. Many of these settlements are still used by shepherds and other people. You can see on the waterfront Roman ruins going down into the water. It is believed that this channel formed around about 2,000 years ago when the land sank and the original city of Telentos was flooded. Telentos has its own fishing fleet as well as a sponge gathering fleet which was at sea when we were there.

Most of the residual adult male inhabitants of Telentos were severely affected by decompression sickness in one shape or form. At least two older people both had the sequelae of severe decompression sickness. One man was beating a squid using his left hand. He was paraplegic and as well he had a fixed flexion deformity of his right hand. Still photographs do not depict the disability of these people very well. It is when they try to walk that you appreciate just how severely handicapped they are. One retired diver who still goes fishing, can only walk with the greatest of difficulty. He has a fixed extensor spasm in both legs. It would be ideal to have a movie camera to show how these people do get around. They are very affable, very kindly, friendly people who certainly do not mind being photographed or showing their disabilities.

When we were there, there was only one restaurant and hotel open at the time and we were the only people staying at the place. It was a combined "guest house and restaurant with a liquor licence". The proprietor is a man in his 40s who was severely afflicted by the bends when he was aged 17. Now he has severe spastic paraparesis and in addition he has a gross arthritic deformity of both knees. He was quite happy to let me examine him, but as you know, by trade I am a pathologist and not a neurologist. The deformity was such that you would find in a Charcot's joint. There was