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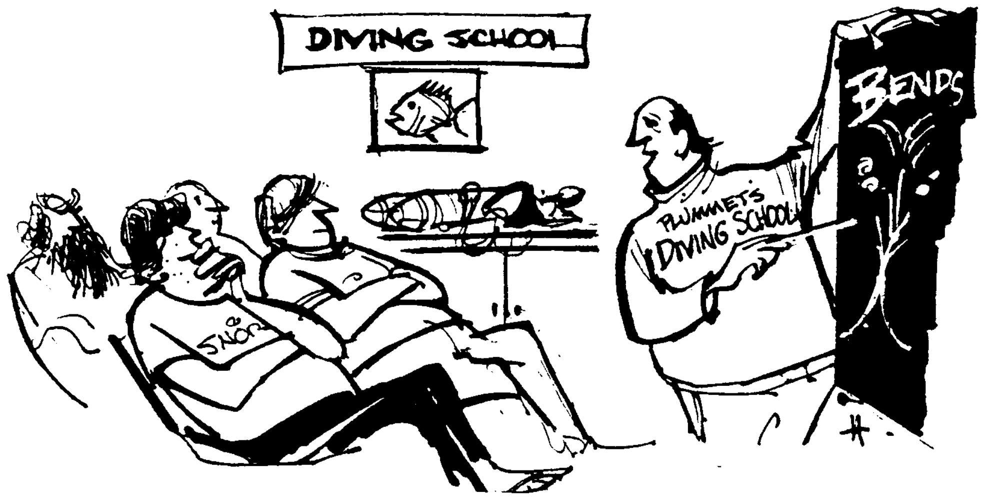

"TRY TO REMEMBER THAT. IT'S AN IMPORTANT THEORY TEST QUESTION."

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OFFICE BEARERS

EDITORIAL

IT CAN NEVER HAPPEN TO ME is the secret Security Blanket most of us wear without giving it a second thought. It can usually prevent us from too brooding a consideration of all the "near misses" we have earned during our day's activities. All this is fine as long as the incidents are all clean ended, but pure poison if it results in burying consciousness of the true significance of events. Two such instances of this human failing are brought particularly to your attention in this issue, to remind you of the necessity to *consider* *the possibility of a "Diving Medicine" problem as the cause of post dive disability. Unwillingness to accept such a possibility allows irreversible changes to occur, changes a lifetime may never erase. The diver for abalone (STICKYBEAK REPORT) would be alive now had he accepted that he was ill when he reached harbour, and the victim in the incident Report (LITTLE BUBBLE, PLENTY TROUBLE) would be a happier person, if either had remembered that there is a strong basis of hard and quite tragic experience behind each entry in the list of "Diving Related Medical Conditions." Most likely neither gave a second thought to the possibility that such things were REAL and could affect THEM. And neither did their friends.*

The rising toll of "Spinal Bends" revealed by the BS-AC. 1982 Diving incidents Panel Report is a warning of changing patterns. This is a condition where, par excellence, early recognition and the immediate start of treatment are critical if there is to be any chance of full clinical cure. It is now known that full clinical cure does not necessarily denote full restoration of the status quo of the spinal cord, but it is certainly worth having:

Divers face danger from the power of the sea, the application of the universal laws of physics and physiology, and from the (protective and offensive) weapons of the sea's inhabitants. Apart from sharks (and boats) most of these marine problems are small but pack a mighty punch. Professor Tony Smith lets us glimpse at the several modes of attack they have on our neuro-muscular functioning, while Dr Straun Sutherland's book tells us about the creatures we had best avoid. Neither will make the average diver seek to emulate Neville Coleman's practical approach to marine life:

The "alerting" value of incident reporting lies in the part it hopefully plays in making divers aware that their problems require treatment appropriate to the dive-related cause. This hurdle passed, the next one is to ensure that the medical contact accepts this possibility when arriving at the diagnosis. SPUMS has distributed wall posters for display in the Casualty Departments of hospitals, and similar posters have been produced in the USA. But nobody can be FORCED to take any notice of them. For this reason, the inclusion of such information in the Divers Log Book, as NASDS has innovated, is a major step in the right direction. It still requires the diver and his friends to bring the information forward for attention. In summary, the message is believe that it can happen to you and make sure that you are so well trained and correct in your diving that it does not!

PROVISIONAL REPORT ON THE 1982 DIVING-RELATED DEATHS (AUSTRALIA)

Douglas Walker

A total of nine (9) deaths were identified, involving all types of diving, one incident resulting in a double fatality. Of the two snorkel (breath-hold) divers, one was the victim of a shark and the other probably had a post-hyperventilation anoxic blackout. Of the five scuba divers, none were experienced and only two had received training. Hired tanks were a significant factor in three cases but there is no way to prevent the buddy from using a valid certificate to hire for another person. Only through the education of divers about the potential for disaster of making scuba available to the untrained can this problem be resolved.

Sudden catastrophic failure of a first stage regulator was the apparent trigger for the double fatality, one of the victims being on her first ever dive, the other was trained but inexperienced. The sudden death of one diver was the result of a heart attack, two previous "sentinel" post-exertion episodes of illness not having been recognized as of significance. The hookah (abalone) diver died when he ran out of luck and suffered fatal decompression sickness. He had many years of disregarding sensible diving practices and three spells in the recompression chamber before this episode. The user of the rebreathing set was taking part in an open sea military exercise and suffered a fatal "air embolism", having made a sudden ascent, possibly to escape "playful" seals though the true reason cannot be known.

CASE REPORTS

These reports are based on evidence presented at coronial inquests, with the exception of case RE 82/1 where the records are not yet available.

Sn 82/1

The victim was a member of a party of bushwalkers, one of whom had brought along a wet suit, weight belt, spear, etc. He was the third person to be given the use of the equipment. His friends started to call him back to the shore as they felt 50m was too far out and because a bag containing cleaned fish and abalone had been washed into the sea. A large fish with a fin was seen near the victim, a brief struggle was observed, and blood was seen in the water. The body was never recovered. Later, a large white pointer was seen in the vicinity of the incident area and was thought to be the fish responsible.

SHARK ATTACK

Sn 82/2

Both the divers involved were experienced breath-hold and scuba divers. The sea was calm and visibility was about 7m. They spearfished for a time, then the buddy returned to their boat to don his scuba while the victim made a further dive to a hole he had found. After 10 minutes, the buddy became alarmed by the non appearance of his friend at the boat and made a search. The victim was found on the sea bed in 12m deep water, the weight belt still in position. Hyperventilation before diving is usual in breath-hold spearfishers and in experienced divers can, by "washing out" carbon dioxide, lead to successful suppression of the urge to breathe, allowing hypoxia to compromise cerebral function. Only observation and rescue of the victim by an alert buddy can then prevent drowning from occurring.

SEPARATION (before the incident). HYPERVENTILATION BLACKOUT

SC 82/1

There were three divers; one of them trained and with his own scuba gear but the others were untrained and grossly ignorant and inexperienced. They were not closely acquainted and seem to have decided to go diving somewhat on impulse. Diver A used his Divers Card to hire two tanks, refusing the suggestion that buoyancy vests should also be hired. Diver B had used A's scuba once before, a solo dive while A remained on shore. There is no evidence that C, the victim, had ever used scuba previously.

The dive platform was a rock ledge about 0.5 - 1m above the moderately rough, 3m deep, water. A checked the kitting up of B and claimed to have checked C, but probably gave only a cursory glance at him. A entered the water first, immediately submerging to adjust a loose strap and so unable to observe his companions. Diver C was wearing A's wet suit and it was too tight, the hood constricting his neck. He was seen to surface in apparent trouble immediately after his water entry, trying to pull the hood from under his chin. He then became submerged again and was seen attempting to regain the rock ledge before being lost to observation. Two children on the shore thought that they had heard the victim try to persuade A that it was too rough to dive, but A denied that this conversation had occurred. Diver A was alerted to the trouble and made a search, finding the body on the rocky seabed. He ditched the tank and weight belt to assist him to surface with the body. Resuscitation was partially successful and the victim reached hospital, but died there from anoxia produced brain damage. Examination of the equipment showed that the regulator had been attached upside down, the hose leading over the victim's left shoulder. This is evidence of the victim's inexperience and of A's failure to make any real check.

DIVING RELATED DEATHS 1982.

CASE	AGE	EXPERIENCE VICTIM	EXPERIENCE BUDDY	WATER DEPTH OF DIVE	WATER DEPTH INCIDENT	EQUIPMENT SCUBA	EQUIPMENT VEST	COMMENTS
BH 82/1	32	Unknown	Not applicable	Unknown	Surface	Not applicable	No	Shark Attack
BH 82/2	27	Experienced	Experienced	12m	Unknown	Not applicable	No	Post Hyperventilation Blackout. Separation before incident.
SC 82/1	22	Nil	B: Trained C: Nil	3m	Surface	Hired	No	Divers Card used to hire 2 scuba for others. Refused to hire vests. Separation. Incorrect assembly equipment. Too tight hood. Poor choice dive platform. Rough sea.
SC 82/2	58	Trained but Inexperienced	Trained but Inexperienced	24m to 42m (?)	24m to 42m (?)	Hired	Not inf-lated	Separation when low air situation. Acute heart attack. Preceeding unexplained illness.
SC 82/3	19	Untrained	Trained but Inexperienced	12m	5m	Hired	No	Unknown problem caused incapacity. Divers card available to hire for other person. to hire Buddy valiant attempt to save.
SC 82/4	33	Trained but Inexperienced	Nil	7m	Unknown	Own	Not infl.	Diver card used to hire for other person. Error disconnection vest tank.
SC 82/5	27	Nil	Trained but Inexperienced	7m	7m	Hired	Not infl.	Explosive failure 1st stage. 1st Dive. No CO_2 cylinder in vest. Failure to attach scuba feed to vest.
H 82/1	41	Untrained but Experienced	None	20m to 25m	Not Applicable	Own	No	Decompression sickness. Severity DCS not recognized.
RB82/1	21	Trained	Trained	Unknown	5m ascent	Army (rebreathing)	Not applic	"Air Embolism"

GROSS IGNORANCE. ROUGH SEA. INAPPROPRIATE DIVE PLATFORM. USE OF ANOTHER'S "DIVERS CARD" TO HIRE SCUBA. NO VEST. SEPARATION. INCORRECT ASSEMBLY OF EQUIPMENT. TRAINED DIVER'S IRRESPONSIBLE LOAN OF EQUIPMENT AND USE OF DIVERS CARD.

SC 82/2

Though trained, the victim had found it necessary to take several courses of instruction before obtaining certification and was still inexperienced. The Coroner made strict investigation of the training and both Diving Schools were doubtless pleased that they had maintained good records. There was a history of two episodes during training where the victim had surfaced from a dive and then become cyanosed and "blacked out". She had neither attended a doctor nor told her husband, her buddy on this dive, concerning these events. It was a boat dive and the skipper checked that everyone was certified, correctly equipped, and had buddies. The site was a reef at 24m descending to 40m approximately. The victim and buddy were to remain at 24m, a depth condition given because of age and inexperience. They intended underwater photography. After 20 minutes, they decided to ascend as their contents gauges showed a low air situation. They started to leave the bottom together but immediately became separated and only one reached the surface. A search was instituted immediately the victim's absence was noted. The body was found still with all equipment intact and with the regulator in the mouth, buoyancy vest uninflated, at about 42m depth. The tank was showing empty on the contents gauge. Autopsy revealed the presence of significant coronary artery disease in one of the main vessels and it was suggested that a fatal cardiac arrhythmia had been triggered by an out-of-air stress, though this cannot be proved. It is suggested that the victim had lost part of her photographic apparatus and started a final search for it when she was expected to start the ascent.

SEPARATION. LOW AIR SITUATION. CORONARY ARTERY DISEASE. EXCEEDED PLANNED/ ADVISED DEPTH. RAN OUT OF AIR.

SC 82/3

As was their usual practice, the victim and his buddy hired scuba equipment before their camping holiday, the buddy using his "Divers Card" for this purpose. Neither was experienced, the victim indeed having been advised that he should not undertake scuba diving after he had attended a few diving lessons some time previously. His parents were unaware of this situation. They entered calm water together from a jetty and, after an initial difficulty with the victim's regulator had been resolved, started a slow swimming descent. When they were at about 15ft depth, the victim seemed to suffer some pain. The buddy assumed the cause to be cramps in the legs and started to rub them, but was kicked away. Realizing that something was wrong, he ditched the victim's weight belt, receiving another kick at this time. As the victim continued to sink and had let the regulator drop from his mouth, he next attempted to offer his own regulator but was repulsed. He therefore ditched the victim's back-pack and brought him to the surface. He was too fatigued during his efforts to tow his friend back to the jetty to call for help and it was only after the victim exerted a final flurry of activity and sank out of his grip that those watching from the jetty realized that this was a "for real" emergency. The body was recovered 15 minutes later, after the exhausted buddy reached the jetty. There was no air lack or other equipment problem.

INEXPERIENCED. UNTRAINED. HIRED TANKS USING BUDDY'S DIVERS CARD. NO BUOYANCY VEST. UNEXPLAINED PROBLEM CAUSED INCAPACITY. PANIC. VALIANT BUDDY ACTION. SURFACE TOW PROBLEM.

SC82/4 & SC82/5

These divers died in calm water soon after commencing their dive. There were no witnesses and the tragedy was discovered only when their bodies were found floating at the surface. It is believed that diver A had owned his twin tank scuba for 18 months to 2 years. He had bought it from a friend on the understanding that he intended to take a diving course. He is thought to have completed a course about six months before this incident and to have hired a scuba unit from the dive shop where he obtained his training in order to take his friend (diver B) for her first dive. Examination of the equipment indicates that shortly after leaving the surface, diver B's first stage explosively free flowed when the diaphragm disintegrated. This would have blown the regulator out of the victim's mouth, vented the tank's air, and produced immediate panic. Drowning probably ensued rapidly. Diver A is assumed to have attempted to give aid and to have drowned also, though his regulator was still in his mouth when the body was found. Diver B had a buoyancy vest but it did not have any CO_2 cylinder and the tank hose supply was not connected. Diver A had a FENZY Vest but had, in error, turned the wrong tap and *disconnected* the air bottle rather than turning it on. Only 500psi had been used from the tank he was using (the other was turned off), indicating that the incident occurred early in the dive.

TANK HIRED USING BUDDY'S DIVERS CARD. FIRST DIVE. TRAINED BUT INEXPERIENCED BUDDY. CATASTROPHIC EQUIPMENT FAILURE. BUOYANCY TEST WITHOUT CO_2 CYLINDER. BUOYANCY VEST USE ERROR (DISCONNECTION).

H82/1

He was a man respected in his community, an abalone diver with 15 years experience, but no training. He had received treatment for bends on three occasions, the most recent being 6 months previously. He followed the usual abalone diving practice of keeping no accurate note of the depth and duration of his dives but seems to have been working for 4-5 hours at a depth of 60-72 feet, though he stated the depth as 50ft. He had not left the water during this time though he had briefly surfaced each time (4-5) as a full bag was raised. No decompression stops were made. On reaching harbour he admitted excessive fatigue and seemed to be slow. However he denied that he was ill and returned home, arranging to dive again the next day. About 7 pm, four hours after he had surfaced for the last time, he telephoned a friend to say that he had the bends and needed treatment. He stated that the symptoms had commenced at 6.30 pm and that he was now finding breathing difficult. He was quickly taken to the local RCC and compressed to 60 fsw gauge. When seen by a doctor at 10.30 pm, he was seriously ill and an IV drip was started. His condition seemed to improve and he was taken from the chamber at 1.30 the next morning. Unfortunately, he suffered a relapse two hours later. Despite recompression to 165 fsw gauge death occurred as pressure was being reduced to 60 fsw gauge.

SEVERE DECOMPRESSION SICKNESS. TOTAL NEGLECT OF DIVE TABLES. DELAY IN RECOGNITION OF SEVERITY OF DCS.

RB 82/1

During an open water military exercise, the buddy pair of divers were aware of the presence nearby of seals. At one stage of the dive, the dive leader came to the surface to establish their position, leaving the victim at the depth of their buddy line. However, shortly later, the victim was seen to break the surface forcefully. The full details are still not available but it is presumed that an explosive ascent had been made and fatal cerebral "air embolism" resulted.

DISCUSSION

Shark attacks' are rare and this one was unpredictable. Film makers find difficulty in attracting sharks when they want to so the importance of the fish and abalone lost into the sea cannot be evaluated as a risk factor. Hyperventilation is a known risk to all experienced spearfishermen and this death illustrates that it is deadly when anoxic blackout occurs and there is no buddy watching and ready to effect rescue.

The scuba deaths illustrate the risks taken when scuba is obtained and used by untrained and inexperienced. Though the sudden equipment failure of case SC 82/5 could have resulted in the drowning of even a trained diver, the death of the buddy was at least in part a result of his inexperience. The hiring of the scuba in case SC 82/2 was completely legitimate. It is not known whether the victim had any awareness of her ill health and therefore the death can be considered as something which could have occurred at any time, anywhere, though the separation and underwater situation made a fatal outcome unavoidable. The value of keeping good records of training, and of correct diving procedures being followed, is thoroughly apparent, as severe adverse publicity would have affected the diving instructors in this case had they not been able to satisfy the Coroner. Nowadays the relatives of victims are more likely to seek to place responsibility on others than on the victim's own actions.

The hookah diver suffered the, thankfully rare, consequences of disbelief in decompression procedures. Unfortunately, the serious nature of his symptoms was not initially recognised and fatal changes proceeded despite the initial improvement.

Rebreathing units are full of problems and must NEVER be used unless special training has been received. Full details of this case are unavailable but it is known that immediate resuscitative attempts were unavailing. It illustrates that even an oxygen embolus can be fatal.

ACKNOWLEDGEMENTS

This report, like its predecessors, could not have been made without the ready support and assistance of the Attorney-General's and Justice (or Law) Department in each State, the co-operation of the Police in elucidating extra details in certain cases, and the active interest and assistance of several organizations and individual divers. The support over the years of the AUF and Instructor Organizations is noted with appreciation. It is hoped that such support will continue and increase.

UNUSUAL INCIDENTS FROM THE PAST

Number 1 - 1955

"Three of us were waiting for a lull in the swell to get into the water easily when I saw a boy out beyond the waves frantically tear off his mask and flounder about desperately in about 20 feet of water. I immediately drew my friends' attention to him and off we went.

It was quite obvious what had happened to him when we reached him: his thick, long underwear, only held up by a belt, had fallen down and become entangled about his legs.

The moral of this story is - if you wear longjohns, wear your costume over the top of them."

Australian Skindiving and Spearfishing Digest, October 1955

PROJECT STICKYBEAK

This project is an ongoing investigation seeking to document all types and severities of diving related incidents . Information, all of which is created as being CONFIDENTIAL in regards to identifying details, is utilised in reports and case reports on non-fatal cases. Such reports can be freely used by any interested person or organization to increase diving safety through better awareness of critical factors. Information may be sent (in confidence)

Dr D Walker
PO Box 120
Narrabeen NSW 2101.

LITTLE BUBBLE, PLENTY TROUBLE

A cautionary tale taken from the Project Stickybeak Non-Fatal incident file.

This dive was made by two divers who had trained together 18 months previously and continued regular diving as buddies. There were two non-divers left in the boat. The water was calm with a slight current, the depth 14m, the visibility 5-8m, and the sea bottom flat and sandy. There was no formal dive plan but they practised good buddy nearness at all times. The victim carried a catch bag and a speargun, his buddy a speargun. The buddy was aware that there was a spent CO_2 cylinder in his buoyancy vest but corrosion had prevented its removal. A pleasant, trouble free dive was fully anticipated.

Approximately 35 minutes into the dive the buddy motioned to the victim that he was having difficulty in breathing from his regulator. They were close together and able immediately to commence buddy breathing using the victim's single regulator. However, after a couple of exchanges of the regulator the buddy handed it back and left the bottom, bolting for the surface. The victim immediately followed, catching him at about 3m depth, having ascended about 10m. Both divers had been negatively to neutrally buoyant at the bottom. The victim remembers that the ascent was controlled and, if anything, slightly arduous.

Together again at 3m the victim again attempted to establish buddy breathing, but after a few more breaths the buddy headed for the surface again. The victim followed and believes that he made this 3m or so ascent without the regulator in his mouth, and that he held his breath because the surface appeared to be just above him.

Both divers hit the surface at almost the same time and fortunately the boat had spotted them and was underway towards them. The victim inflated his buoyancy vest and supported his buddy, but neither diver was unduly upset as the water was calm and the boat near.

The victim, who was now holding 2 spearguns and a catch bag, now noticed that he had no feelings in and could not move his right arm and leg. He informed his buddy, who then assisted him in removing his gear and helped him to the stern of the boat. From here he was hauled rather uncomfortably face down over the stern ladder and inboard by the two in the boat. By the time the boat reached shore, 10-15 minutes later the victim found he was able to walk without assistance to a private car, which took him to hospital. He told his story at the Casualty Department and underwent a full physical examination. He was not in any great discomfort and felt that the symptoms were diminishing. Examination included ECG (which was normal), chest x-ray and neurological check of reflexes. He was told that he had "a bubble in the neck" and "shadow where air had expanded from the lungs" He was placed in the recovery ward and advised that he would be allowed home next morning. As time progressed, feeling began to return to his limbs, though he was experiencing an unusual need to empty his bladder. No treatment other than bed rest was given.

The next morning (day 2) he attempted to get out of bed and found he could not move his legs, they lacked co-ordination. He was subjected to further neurological and x-ray tests. He could not hold his legs up when lying down, cold felt hot and sharp, blunt.

He remained in hospital and over the next few days his condition slowly improved. He was not offered any treatment, drugs or physiotherapy during his hospitalization. He was discharged on day 6 with advice to take a week off work. This he was unable to do as he had work commitments. His condition, he was told, was due to shock. He saw a hospital document which gave the diagnosis as "Pneumo-mediastinum".

Four weeks after the incident, he felt that he was only just recovering his normal walking ability and was still suffering sensitive legs and feet and uncontrolled twitching of the legs.

DISCUSSION

The following points arise from this tale.

1. The initial problem was inadequate air flow, there still remaining 8000kpa. It was suggested that this was the result of a faulty J-valve and/or the tank valve had been inadequately turned on.

2. The correct response to this situation was either an immediate ascent (he was having difficulty but was not out of air) or had the buddy had an octopus regulator there would have been a trouble-free ascent. Buddy Breathing ascents are notoriously full of potential for disaster and should only be attempted by

those few divers who are highly trained in it with each other. Break-away is common when difficulties are encountered. In this case it was the donor who suffered pulmonary barotrauma.

3. Starting a dive with non-functioning equipment (the vest) introduces an unnecessary risk factor.

4. The value of the buoyancy vest, the nearby buddy, and alert surface cover are illustrated.

5. Neither diver accepted the significance of the symptoms. DIVERS MUST BE ALERT TO ASSOCIATE POST-DIVE SYMPTOMS AS DIVE RELATED, THAT "DIVING MEDICINE PROBLEMS" DO EXIST AND ARE NOT THE INVENTION OF WRITERS OF DIVING BOOKS.

6. The Neurologist and others were not divers and were seemingly unaware of the relevance of the diving element of the story presented by the victim. SELF PRESERVATION REQUIRES THAT THE DIVER IS ABLE TO COMMUNICATE THE BASICS OF DIVING MEDICINE. Management would have been different had the problem been made known to a Diving Medicine Specialist.

7. This was a case of Pulmonary barotrauma with mediastinal and neck "surgical" emphysema and clinical evidence of air embolism. The cord was affected from the consequences of the CNS "shock" response. This matter will be discussed more fully by Dr John Miller in a later issue.

ACKNOWLEDGEMENTS
This important and informative report has been reprinted virtually as received. Its writer is to be highly commended and is sincerely thanked.

UNUSUAL INCIDENTS FROM THE PAST

Number 2 - 1965

A Tongan's Grim Battle

A Tongan spearfisherman was seriously injured in a curious accident last week, reports the Tongan newspaper, the Chronicle. He is Hausia Sekona, who went night-diving with a group of others aided by petrol lamps.

The Chronicle says that from reports gathered from the other divers, it appears that Hausia was pierced through the head by a haku, a swordfish of the Bar family.

These fish are an occupational hazard to night divers as they are attracted to the light, and skip along the surface at a high speed towards it.

One of the witnesses said that he saw what he thought was Hausia, struggling with what appeared to be a good fish, so he went to his help.

By the time he arrived, Hausia was unconscious, head-down and bleeding profusely from the head.

From this observation, the Chronicle continued, the divers surmised that what had been seen was a haku with its sword jammed in Hausia's head, and struggling to free itself, which it did before they appeared.

The Tongan Medical Department reported that the wound which was 1 inch long and 1 inch deep caused the base of the skull to fracture and ruptured the covering of the brain and spinal cord.

The latest report of Hausia's condition said that he was progressing satisfactorily.

Australian Skindivers Magazine, December 1965

UNUSUAL INCIDENTS FROM THE PRESENT

Number 1 - 1983

COMPRESSED-AIR CYLINDER TAP DEFECT

Noel Roydhouse

On the 12th of January 1983, when diving for scallops in 80 feet of water in the Cavalli Passage, I left the surface with an air cylinder whose gauge indicated 3,300 psi. The flow of air was tested and found to be adequate at the surface. A fairly rapid descent brought me down to 80 feet where my buddy diver looked round, saw me six feet away, and started doing his collecting. At this stage I suddenly had great difficulty in breathing, as though my air supply had run out. A look at the pressure gauge, which now showed 500 psi, and I decided that UP was a good place to be. The only thing I could think of at this stage was that I had not turned the tap on and had descending using the air in my circuit, although that was obviously not feasible. I placed myself in the upright position and as I did not appear to be moving upwards came to the conclusion that I should inflate my buoyancy compensator, and decided that I would split it 50/50. As I did not appear to be rising at the rate which I needed, I dropped a 2 pound lead weight (I have a vest type diving outfit which has the weights in pockets, a built-in compensator and back pack). My rate of ascent increased and I began an emergency ascent. My rate of ascent was equal to my bubbles for the first half, and faster than the bubbles for the second. I used the continuous breathing cycle ascent with an over-emphasis on the expiratory phase. I reached the surface and held up my right hand to indicate my need for help from the drifting, diving flag equipped, boatman. After a pause of five seconds, he flew into action, started the engine and came to collect me.

The defect was that the tap had only been turned 2.5 turns on instead of six. This gave enough air at the surface but not enough was supplied at a depth of 80 feet. The cause of the malfunction was corrosion on the stem of the tap meeting further corrosion in the seating of the tap once the tap had been unwound 2.5 turns. It was an aluminium cylinder and was due for a check in April 1983. With manipulation, this tap could be turned on fully and it was only because a light touch had been used to open it that the tap had stopped after 2.5 turns.

The moral of this story is that you should always ensure that you tap is turned on fully, and you should know how many turns is full on.

CEREBRAL AIR EMBOLISM CASE REPORT SYMPTOMS OF CEREBRAL AIR EMBOLISM COMING ON FIFTEEN MINUTES AFTER RESCUE

Reprinted from DIVER (Sept 1982) by kind permission of the Editor.

A seventeen year old Oxfordshire diver, Tricia W, suffered a cerebral air embolism after surfacing too rapidly at Stoney Cove, Leicestershire, early this year (1982). She was successfully treated in the Centre's recompression chamber.

The accident took place one Sunday when there were more than 200 divers enjoying the facilities of the cove. Tricia reached the surface in a panic and the rescue boat responded promptly to her screams. She was carried swiftly (feet higher than head) to a hut where her condition was assessed, and she seemed none the worse for her experience. Then, fifteen minutes later, she cried, "Alan, I can't see you". Her vision had gone.

Only three minutes passed before she was locked into the recompression chamber with a first aid man, David Crouch, and compressed to 50m. Surgeon Commander Thomas Shields, of the Royal Navy Diving Division, HMS Vernon, was consulted by phone and he decided to drive immediately to Stoney Cove.

He was impressed with what he saw when he arrived and spent three hours drawing up special tables of pressure and oxygen levels before returning to Portsmouth.

It took 39 hours to complete Tricia's treatment in the chamber and 43 year old David Crouch lost about two stone in weight during his constant vigil at her side. The team outside, which included the Centre's directors, Harry Chapman and Alan King, monitored the compression treatment and kept up a supply of clothes, washing materials, medical needs, food and drink. For the last eight hours the Centre's manager, Andy Fraser, joined the patient and attendant in the chamber as they breathed pure oxygen. This was so that he could help the watch for signs of oxygen poisoning, a risk at this stage of the treatment.

Happily Tricia has made a complete recovery from her ordeal, thanks to the outstanding efforts of all involved.

BS-AC REPORT REVEALS "EPIDEMIC" OF SPINAL BENDS

The British Sub-Aqua Club has been collecting, and reporting on, diving related incidents for longer than any other organisation in the world. Its most recent annual report, presented at the BS-AC Diving Officers' Conference (31 October 1982), maintains the tradition of making the data available for general discussion. It contains Information of all types, not limiting itself to the UK or to BS-AC member incidents, a point to remember when reading it. Despite the efforts of the Diving Incidents Panel, many incidents are but sketchily reported. Nevertheless their inclusion is of real value because they help the discovery of the most commonly occurring problems, or at least the problems divers think are report-worthy. Over the years such a policy has indicated the danger areas of poor boatmanship and of Deep Rescue tests, among other matters. This year the critical danger areas include the incidence of decompression sickness (DCS), particularly the number of Type II cases, of icy water diving, of ENT problems and buoyancy vest (ABLJ) troubles.

There were nine fatalities noted, though no details were available concerning one. Two victims seem to have suffered "Heart Attacks" while alone, three became separated during ascent (one was a failed buddy breathing ascent in which the donor died) while a fourth drowned at the surface after an Assisted Ascent exercise. One diver was lost under ice, while the last case was the result of trauma from the dive boat's propeller. Non-fatal propeller and ice incidents are detailed also.

The thirty three (33) cases of DCS which occurred are a grave warning of slipping standards, particularly as they included nine (9) spinal bends (or possibly 10) and two (2) cerebral bends. There were also five cases where the diver seemingly deserved, but did not suffer, DCS and one case where the diagnosis was later changed to that of a nipped nerve as the cause of symptoms. One case occurred after a chamber "dive" to 165 feet, and one occurred in a 16 year old.

Unfortunately no details of this case are provided.

Sudden loss of consciousness is a problem where the presence of a buddy is essential for survival. There were five such incidents, two being the result of air embolism, one followed drum perforation at 7m, and the fourth was the climax of events when an apprehensive novice had buoyancy problems while underwater, then "beat the demand valve" (regulator) at the surface and inhaled water. The remaining case occurred in an under-ice dive by a novice and two certificated divers. The novice's weight belt slipped to around his knees, then he ran out of air and snatched the regulator of the nearest buddy, who had to buddy breathe unexpectedly with the third diver. Luckily they broke through the overlying ice as sharing started to become chaotic. The novice was unconscious and had purple lips when he got to the surface, but breathing restarted when his neck was extended. Only training prevented an incautious dive from ending in tragedy.

The members of the Diving Incident Panel deserve more than a vote of thanks. They deserve better Incident reports from divers.

SCUBA ACCIDENTS ON THE MONTEREY PENINSULA AND EXPERIENCE WITH A SINGLE LOCK CHAMBER 1971 - 1981

Takashi Hattori

The primary purpose of a single lock 7ATA chamber is for the transport of diving victims under pressure to a more sophisticated double lock chamber. However, circumstances have caused such chambers with oxygen capability to be used for definitive treatment of the less serious and less complicated cases of decompression sickness (DCS) and arterial gas embolism (AGE). Such a situation has existed on the Monterey Peninsula for the past ten years.

BACKGROUND

This is a review of the scuba diving accidents from 1971 to 1981 and their causes as well as the result of their treatment. Some background information is provided to give an overall picture.

The California Parks and Recreation Department estimates that about 50,000 divers visit the Monterey Peninsula yearly. A conservative estimate is that one-half of these divers are students in diving classes for open water training.

70 per cent of all ocean diving classes held north of San Luis Obispo are held on the Monterey Peninsula. This would include the northern two-thirds of California.

The chamber is located at the Pacific Grove firehouse, and operated by the Pacific Grove Marine Rescue Patrol of which the author is a member.

The author was involved in the treatment, investigation and reporting of almost every case recorded as well as being present for most of the autopsies, which are required for all coroner's cases in California.

ACCIDENTS

The accidents were separated into five categories:

1. In trouble; those who found themselves in a dangerous situation from which they were able to extricate themselves with or without outside help.
2. Near Drowned.
3. Drowned.
4. Decompression Sickness (DCS).
5. Arterial gas embolism (AGE).

TABLE I

DIVING ACCIDENTS ON THE MONTEREY PENINSULA 1971 - 1981

		Subtotal
In Trouble	45	45
Near Drowned	31	
		68
Drowned	37	
DCS (Divers)	18	18
(Flyers)	6	
Arterial Gas Embolism	21	21
		152

Total number of divers on peninsula = 500,000
Total number of divers in classes = 250,000

Table I shows that most of the fatal accidents during scuba diving end up as a drowning. This is in agreement with the University of Rhode Island study. There were 37 drownings and 6 fatal cases of AGE. There were no deaths from DCS.

In trouble, near drowned and drowned

Heavy surf contributed to more accidents and fatalities than any other single cause. Most of these were due to entering the surf against one's better judgement, but a few were victims of the rapidly changing conditions for which Monastery Beach is notorious.

Unknown. Most were divers who failed to surface after a dive and whose bodies were recovered hours to days later. Autopsy usually was not too helpful due to the deteriorated condition of the body.

Deep dive. Of the eight divers known to me who have gone deeper than 150 feet, five are dead. I am aware that many more have gone to this depth and beyond and returned safely, but the percentages are certainly not good.

TABLE II

IN TROUBLE,
NEAR DROWNED AND DROWNED DIVERS

Cause	In Trouble	Near Drowned	Drowned
Heavy Surf	31	7	12
Unknown	0	2	12
Deep dive	0	0	5
Kelp	1	4	2
Exhaustion	2	2	1
Air embolism	0	3	1
Cardiac	3	0	1
Medication	1	1	1
Equipment Failure	0	1	0
Hypothermia	0	2	0
Buddy Breathing	0	1	0
Out of Air *	1	3	1
Hyperventilation	1	0	0
Hypoglycaemia	1	0	0
Miscellaneous	4	6	1

* (4 AGE)

Kelp. Entanglement in the kelp peculiar to the west coast has led to a significant number of accidents including death by drowning.

Out of air. Here is an interesting breakdown of what the end results were in eight cases:

air embolism	3
near drowning	3
AGE and drowned	1
in trouble	1

Of the other contributing causes of accidents, almost all have been mentioned at one time or another by the late Dr Charlie Brown in his many articles in magazines and journals on diving medicine.

The survival figures of the drowning accidents approximate those reported by Dr Modell of 91 cases over a ten year period in CHEST in 1976.

All who were awake on admission to the emergency room (ER) survived.

All who arrived with spontaneous respiration and heart beat survived.

None admitted having cardiopulmonary resuscitation (CPR) and with fixed dilated pupils survived.

None survived whose arterial pH was 6.8 or lower, or whose PaO_2 was below 40 mmHg.

Two survived with mild to moderate brain damage.

Two are still comatose two and four years after the accident.

PEEP was used in all cases requiring endotracheal intubation.

Decompression sickness

There were no deaths from decompression sickness. I am curious as to why we had so many peripheral nerve cases in comparison to Type I and other Type II cases.

TABLE III
DECOMPRESSION SICKNESS

TYPE	DIVERS	FLYERS
Type I (pain only)	4	3
Type II	4	3
Type I & II (mixed)	10	
Peripheral nerve	5	
Spinal cord	2	
Staggers	1	
Chokes	1	
Cerebellar	1	

Statistics include both divers and flyers. Table 5 was the most often used US Navy Table (14 of 25 cases) with one recurrence left with some permanent residual signs. This diver initially developed weakness of both lower extremities on surfacing from an uneventful dive. He had to be assisted into the boat, but by the time he was brought ashore and to the firehouse, he was asymptomatic except for a slight paraesthesia of the legs. Paraesthesia cleared within ten minutes at 60 feet on oxygen so the treatment was completed on US Navy Table 5. About two hours later he developed paraplegia while in the hospital. He was transported to the San Diego double lock chamber in our portable chamber for further treatment. One case of staggers was treated with oxygen at 35 feet for two hours on Dr Behnke's advice. He was cured with no residual. This was before we started using oxygen by mask, so we had to flood the entire chamber with oxygen.

One case of cerebellar involvement with ataxia cleared completely during transport to Monterey. "He received 500 ml of dextran and 20 mg Decadron IV and oxygen by mask en route. He was observed overnight in the hospital and discharged the following day asymptomatic. In the 20th UMS workshop on the treatment of serious DES and AGE, Dr Fructus reviewed 67 cases of DCS who had to be transported over long distances to the chamber. During transport some received no supportive treatment, some received oxygen by mask, others received Dextran, Cortisone or aspirin IV. Those who received no supportive treatment during transport showed no change in their condition, but among those who did receive such treatment, a surprisingly large number improved or became asymptomatic.

TABLE IV
DECOMPRESSION SICKNESS
TREATMENT PAIN ONLY TYPE I

Table used	Number of cases	Cleared after first treatment	Recurred, cleared with repeat treatment
5	5	4	1
6	1	1	0
1A	1	1	0
TOTAL	7	6	1

TABLE V
DECOMPRESSION SICKNESS TREATMENT
TYPE II AND TYPE I & II

Table used	Number of cases	Cleared with one treatment	Cleared with more than one treatment	Permanent residual symptoms
No * recompression	1	-	-	
5	9	6	2	1
6	5	4	1	0
6A	2	1	1	0
O2 at 35 feet for 2 hours	1	1	0	0
TOTAL	18	12	4	1

* cleared during transport on oxygen, plus IV steroids and dextran

TABLE VI
DECOMPRESSION SICKNESS
TIME FROM ONSET TO TREATMENT

Time in hours	Number of cases	Cleared with one treatment	Better or improved or cleared with repeated treatment	Permanent residual symptoms
Less than 1	5	4	0	1
1 - 2	4	3	1	0
2 - 4	3	3	0	0
4 - 6	3	2	1	0
6 - 24	4	3	0	1
24	5	3	2	0
* No recompression	1	-	-	-
TOTAL	25	18	4	2

* Cleared during transport on oxygen, plus IV steroids and dextran.

Fifteen of 25 cases were treated within six hours of developing signs or symptoms of DCS. Most of those treated with more than six hours delay were divers who had gone home before calling for help or had hoped that whatever was bothering them would go away.

Arterial Gas Embolism

Table VII shows that only 4 of the 21 cases of AGE developed any sort of haemoptysis. Older texts emphasised this finding. Perhaps the small number of cases in my series was unrepresentative.

Before we added oxygen capability, we did treat one case of rapidly improving hemiplegia on US Navy Table IA. Only one death occurred in the chamber. This diver died while our chamber was being passed into a double lock chamber in San Diego. Death was due to a combination of air embolism and drowning. All six fatal cases were found unconscious or were unconscious on admission to the ER having CPR. About one-third of the cases showed neurological involvement other than unconsciousness. Due to the proximity of the chamber, 7 of 14 cases that were recompressed were treated within one hour of the accident, and an additional four cases within two hours. Two cases cleared without recompression.

Pure panic was the biggest culprit leading to AGE. Also, three cases occurred even though the divers claimed they were letting air out during ascent (two

TABLE VII
ARTERIAL GAS EMBOLISM

Unconscious	(3 haemoptysis) (6 fatal)	11
Stuporose	(1 haemoptysis)	3
Hemiplegia		1
Hyperactive reflexes		1
Ankle clonus		1
Vibration/vestibular		1
Hemiparesis		1
Haemoptysis, weakness		1
Pulmonary, renal		1
TOTAL		21

TABLE VIII
ARTERIAL GAS EMBOLISM TREATMENT

Table used	Number of cases	Cleared with one treatment	Cleared with repeated treatment	Died
1A	1	1	0	0
5A	1	1	0	0
6A	3	3	0	0
4	9	7	1	1
Cleared Spontaneously	2	-		
Dead on arrival	5	0	0	5
TOTAL	21	12	1	6

TABLE IX
ARTERIAL GAS EMBOLISM
TIME OF ONSET TO TREATMENT

Time	Number of cases	Cleared with one treatment	Cleared with repeated treatment	Died
1/2 hr	1	1	0	0
1/2 - 1 hr	6	6	0	0
1-2 hrs	4	2	1	1
2-3 hrs	1	1	1	0
3-6 hrs	2	2	0	0
Cleared without recompression	2	-	-	-
TOTAL	16	12	2	6*

* 5 Dead on Arrival

of these were during free ascent training one-on-one facing their instructor). Although the second edition of Diving and Subaquatic Medicine is somewhat dubious of the so-called 'air trapping' in the lower lobes that might happen with the 'blow and go' type of ascent, I do not think it can be entirely discounted. It may be because I do not have any other explanation, though air trapping in bullae too small to be seen on X-ray could be a factor.

TABLE X

CAUSE OF ARTERIAL GAS EMBOLISM

Panic	8
Exhaling (free ascent)	3
? Breath hold	3
Unknown	3
Buddy breathing	2
Breathing	1
Pulled to surface	1
TOTAL	21

FIRST OCEAN DIVES

Non-fatal accidents

Among the 29 non-fatal cases, rough surf was the worst culprit, responsible for 13 accidents. Air embolism was next with six cases. The remainder were singular occurrences. The cases involving hypothermia, out of air, and exhaustion all involved students at the tail end of their particular class, being 'checked out' by the instructor, and in each case were in the water for about an hour. The out of air student was using rented equipment and did not know how to turn on the 'J' valve. The hypothermic student could not afford a wetsuit so he was snorkelling around for an hour in a surfer's suit. He had become so cold that the regulator fell out of his mouth and he started to drown and would have if his buddy had not pulled him to the surface. Rectal temperature was below the 90 degree calibration of our thermometer.

Fatal accidents

Three of the eight cases were due to air embolism. All three were due to panic (two were during free ascent training). Two drowned for cause unknown. The rest are self explanatory.

STATISTICS

For the most part, there are no comparable figures for those who got "into trouble", or the number of near drownings as compared with the drowned, or the number of accidents in each category due to running out of air, or from hypothermia, or rough surf, etc.

As for fatalities, the percentage of deaths due to AGE (14%) and first ocean dive (18%) are comparable to the University of Rhode Island (URI) statistics of 21% for AGE and 15% for first ocean dive. The percentage of drownings is much higher (85%) compared to URI (62%).

TABLE XI

ACCIDENTS ON FIRST OCEAN DIVES

NON FATAL CASES	
Rough surf	13
Air embolism	6
Chokes	1
Out of air	1
Hypoglycaemia	1
Hypothermia	1
Exhaustion	1
Medication	1
Epilepsy	1
Ear squeeze	1
Laryngospasm	1
Near-drowning	1
TOTAL	29
FATAL CASES	
Air embolism	3
Cause unknown (drowned)	2
Cardiac	1
Medication	1
Rough surf	1
TOTAL	8

TABLE XII

RATIO OF ACCIDENTS: DIVERS

Based on 500,000 divers

Accident	152	1:3,300
In trouble	45	1:11,000
Near-drown	31	1:17,000
Drowned	37	1:14,000
Non-fatal	75	1:7,000
Fatal	43	1:12,000
DCS	18	1:28,000
AGE	21	1:24,000

First Ocean Dive (250,000 divers)

Non-fatal	29	1:8,400
Fatal	8	1:31,000
AGE	9	1:28,000
TOTAL	37	1:6,800

Drowning	34/43 = 85%
AGE	6/43 = 14%
First ocean dive	8/43 = 18%

Some surprising figures are that the incidence of AGE on first ocean dives is not that different from the overall incidence. It was 1:28,000 for the first ocean dive, and overall, 1:24,000.

The non-fatal accidents were also about the same, 1:8,500 for the first ocean dive and 1:7,000 overall.

The incidence of fatalities among the first ocean dive was almost one-third less than overall, 1:31,000 for the first ocean dive, and 1:12,000 overall.

CONCLUSIONS

Rough surf presented the greatest hazard to life and limb on the Monterey Peninsula.

Arterial gas embolism is a distinct hazard on the first ocean dive.

Signs and symptoms of AGE need to be revised as to their frequency of appearance as well as which are emphasised:

1. Haemoptysis, "coughing up blood". True haemoptysis results from bleeding within the lungs for whatever cause with subsequent "coughing up" of blood. Twelve years ago this was emphasized to the extent that I thought practically all cases of AGE had haemoptysis. This is not so, only one in five cases showed this in my series. One can also aspirate blood from a nose bleed or sinus squeeze, so these need to be kept in mind.

2. Loss of consciousness was the most common finding in AGE, but about one-third of my series showed neurological signs and symptoms other than unconsciousness.

3. Any neurological sign or symptom caused by AGE can occur with DCS, so history is all important. An unconscious patient cannot give a history. More than once I have been on the verge of recompressing a diver because I could not rule out AGE for the simple but all important reason that no-one who could give some kind of history of the diving accident accompanied the victim to the emergency room. One must always remember that if the physician cannot rule out the possibility of AGE or of DCS for lack of history, the victim will have to be recompressed!!

Panic for whatever cause resulted in a disproportionate number of AGEs.

Chances of survival are grave for those admitted to the ER unconscious with fixed dilated pupils and requiring CPR.

Instructors need to be conscious of the amount of time spent in the water by classes. Running out of air can result in a serious accident.

In spite of the hazard of AGE, I believe controlled emergency swimming ascent is a desirable part of open water training, BUT NOT ON THE FIRST OCEAN DIVE

This paper was presented at the November 1981 meeting of the North Pacific Chapter of the Undersea Medical Society.

PUBLICATIONS OF INTEREST

Diving Accident Management Manual

Dick Rutkowski (NOAA and Florida Underwater Council)

DAN Underwater Diving Accident Manual

G Yancy Mebane MD, Arthur P Dick MD)

NASDS Diving Log Book

These publications illustrate variations on the theme of presenting basic Diving Medicine information to those to whom a diver may apply for advice and management after a possible "diving problem". The first line of protection from inappropriate management will always be the awareness of the victim diver and his companions of the possible diagnosis and correct treatment and their persistence in putting this convincingly to persons without knowledge of Diving Medicine. This is a "selfish" reason for divers to understand and remember this portion of their training days. Unless divers recognise that they may be suffering from a "bend", "squeeze", air embolism, spinal bend, post-hyperventilation blackout, etc, there is very little chance that anyone else will diagnose their problem. Without early and correct diagnosis, treatment will be possibly critically inadequate.

The NOAA/Florida Underwater Council publication is in the nature of educational material to inform and alert doctors, etc, who are "at risk" of being presented with divers with problems. It has a management flow chart which includes both the local (Dade County Fire Rescue) and the national Diving Accident Network (DAN) contacts for advice and management. It also contains a report form to send with the patient. Some copies of this booklet have been kindly made available for supply to interested readers (please send $1.00 p&p).

The DAN booklet offers more detailed information on diving accidents, with concise advice on diagnosis and initial management. The Management Flow Chart is much simpler than that in the NOAA booklet, though similar in intent. Both these publications stress that there must be NO ATTEMPT AT IN-WATER RECOMPRESSION. The emergency phone number for DAN is clearly printed. The booklet deserves a place in every (American) diver's dive kit, its design being likely to favourably impress any doctor faced with a diver talking diving problems.

The National Association of Scuba Diving Schools (NASDS) in America is a major force in diver training. Like the other instructor organisations, it is an active supporter of DAN, an organisation based at Duke University. Although DAN was only started in 1981, it was hatched at the critical moment and has benefited from the present understanding of the need for such an organisation of central advice. It has been given wide support, financial as well as oral, and itself intends to co-operate with the University of Rhode Island National Underwater Accident Data Centre. NASDS has combined the DAN booklet with the Diving Log Book, with its record of training and subsequent diving experience, and added a little advice on first aid. This is an excellent idea, especially as the diver is told to take this log book with him to the doctor/hospital. It is a well presented source of all the critical Diving Medicine facts.

There is no present Australian or United Kingdom equivalent of the NASDS Diving Log Book but the concept deserves copying whenever organisations consider reprinting present Log Books. It is designed rather to be carried in the equipment bag than the pocket and seems to be of sturdy construction. Both NOAA and SPUMS have produced information posters for display. Such posters will combine with the production of the DAN Information booklet by a casualty to compel some regard for diving factors in the differential diagnosis of anyone reporting recent diving.

The practical relevance of such a provision of information is well illustrated in a case report elsewhere in this issue. the significance of symptoms suggestive of cerebral air emboli being disregarded.

BOOK REVIEW

AUSTRALIAN ANIMAL TOXINS

Straun K Sutherland

Publisher	Oxford University Press 7 Bowen Crescent Melbourne VIC 3000
Price	Aust $95.00

This book deserves immediate recognition as the definitive book on its subject. It deals with the creatures, their toxins and the care of the poisoned patient. Short of the discovery of new noxious creatures it is difficult to see how the book can be superseded, and certainly never bettered. Despite general opinion to the contrary, it is apparent that it is still possible for a single person, writing with clarity and elegance, to give an authoritative survey of a large body of knowledge. It is certainly a book every medical reference library should hold, though, regrettably, the cost will limit the number of individual purchasers.

The information is clearly presented, with numerous, well chosen, brief case reports. There are maps illustrating the distribution of the animals described and clear notes on the management of victims.

Of most interest to SPUMS readers are the chapters which deal with marine creatures: the sea snakes, jelly fishes, poison-spined fish, the cone shells and the little blue-ringed octopuses. Fish which poison you when you eat them also receive recognition. The human face behind the information flow can be glimpsed briefly in the story of the Octopus and the Parson. This, the nearest the author gets to discussing Sea Monsters, introduces the chapter on Class Cephalopoda. Strictly speaking, it has no relevance to the focus of the interest in octopuses, the small brethren of the family, but it is worth a few of the dollars of the cost to have this incident on record more fully than hitherto. The blue-ringed octopus, a small creature with a highly potent toxin and a retiring, non-aggressive personality, has its few but spectacular exploits recorded. This octopus has not been reported outside the Australian region.

The writing is such that the reviewer found himself fascinated by the sections on snakes and spiders, not his greatest love. The compilation of this book naturally required the assistance and encouragement of the author by many persons, as he acknowledges. It must have been a formidable and daunting task to ensure that nothing (or so it seems) was omitted and that the management advice was up to date. To Straun Sutherland and those also involved one can truthfully say that the result has been worth the effort.

UNUSUAL INCIDENTS FROM THE PAST

Number 3 - 1967

A Bad Story

On April 29th Ted Louis and Dave Rowling were diving in 80 feet of water off Jibbon Point when they came across two complete sets of false teeth.

The story goes that while two men were fishing one day, one of them became seasick and lost his teeth overboard. His companion, being a practical joker, thought he'd have some fun. He obtained a fishing line and on the line he tied his own set of false teeth, and throwing the line over the side, he started to haul it in, calling out to his companion, "Look, I've hooked your teeth for you." "So you have", said the first man promptly, putting them in his mouth. "These don't belong to me" he yelled a moment later, "they don't fit". Whereupon he promptly threw them overboard, too.

Australian Skindivers Magazine. June 1967

SPUMS 1983 SCIENTIFIC MEETING

THE WAIGANI EXPRESS

Ian Lockley

This film is about the salvage of the Waigani Express. The Waigani Express is a container ship, German owned, German officered, and Papua New Guinea-national crewed. She was on a run from Australia to Port Moresby, when they forgot to turn the corner, literally, and took up their selection on the reef at full speed, within sight of a lighthouse. A lot of people have asked how do accidents like this occur? It was quite simple. The officer of the watch was being entertained by the rather gorgeous blonde German radio officer. The lookout, who came from the village which was just beside the lighthouse, was not prepared to go and disturb the First Officer, because he was not quite sure what they were up to. This accident happened on the fourth of July 1981. It certainly was not Independence Day for the crew of that ship. They spend the next four weeks working hard with myself and our team battling, not only the elements, but the German owner, who was an ex-U-boat commander. If anybody was difficult to work with, he took the cake. I think the film shows some of this.

The camera man, Lynton Diggle from New Zealand, did an excellent job. He was able to get his camera into some spots where it was not always appreciated, sometimes under threat of the film being destroyed. But we did persevere and asked him to persevere, because the film was taken primarily for arbitration. The major part of our reward and remuneration for salvage is decided by an arbitrator appointed by the Committee of Lloyds of London. The more we can show him exactly what happened, the easier his job is.

This U-boat commander decided to take it one step further after we re-floated the ship. He transferred the ship from one group of owners to another, then managed to convince Lloyds that it had been very badly damaged and received a settlement for repairs. Then he promptly went to another shipbuilder, who gave him a quote that was about one third of the first one. We were able, with some of the evidence which was on the film, to typify the sort of man he was and prove that this had happened, and have our salvage value increased. This of course, hopefully, increases our reward. Even though this operation took place some two years ago, we have still not been paid for it. This gives you some idea of just how long the process of arbitration can be.

Those interested in seeing this excellent film should contact:

Lynton Diggle,
Film New Zealand
3 Ngaio Road
Titirangi, Auckland 7
NEW ZEALAND.

DECOMPRESSION SICKNESS THREE CASE REPORTS FROM THE CARIBBEAN

Grahame Barry

When we first start off doing diving medicine, we think we can cure all people who have the bends, air embolism and so on. But the more conferences we attend the more we are regaled with horrendous stories of totally failed treatments and people ending up crippled. So to start this conference on a happy note I am presenting two marvellous cases of 100% success. One resulted from the right people doing the right thing in the right place at the right time and the other was probably due to sheer good luck, but nevertheless had a very successful outcome. Neither of these cases is mine, mine is the third case, with the bad result.

The first two cases were dealt with in Trinidad, by a group which I worked with. I think they are fascinating cases, not that they raise any great problems, but show that if one does do the right think, one can do some good.

CASE ONE

In 1976, an inexperienced diver, who was working for a commercial diving company, made a working dive to 70 feet of sea water (fsw). Every now and then horrendous things happen, and these things started to happen in this case. There was a foul up in his air line after 90 minutes at depth. Furthermore he could not get the safety bottle free from his down line. Also, just to make things a little more complicated, he could not get himself free from his harness. His co-worker was on the ball and they buddy breathed from 70 feet to 40 feet, at which time the buddy’s air ran out. So the buddy made for the surface, leaving the patient airless and tied up on the down line.

The buddy reached the surface and gave the news to the diving superintendent. The superintendent, who was also on the ball, put on scuba gear and went down. He found the patient at 40 feet still tied to his lines and unconscious. He brought him to the surface, where CPR was at once begun. The patient, on reaching the surface was reported as having no pulse and no respiration. However, within one minute of starting CPR the pulse returned. Two or three minutes after surfacing, the patient was trying to breathe and then vomited. Within five minutes, the patient was put into the recompression chamber (this was a commercial diving operation, so they had a chamber on site) and taken to 10 feet of sea water for thirty minutes.

By then he was conscious and vomiting, his pulse was stronger and becoming regular. After thirty minutes at 10 feet he was taken out of the chamber and transported by launch and ambulance to a hospital, breathing oxygen by mask all the time.

In the hospital, his clinical examination was entirely normal and the patient felt well. The X-ray of his chest was normal, his blood gases were normal, and his electrolytes were normal. The man was discharged two days later.

I am presenting this as an example of saving a life by prompt CPR and the avoidance of decompression sickness by giving some sort of hyperbaric therapy plus oxygen on the surface. The doctor who saw him in hospital assumes that he probably had glottic spasm, which prevented sea water from entering his lungs and that the increased partial pressure of oxygen in the lungs at 40 fsw kept his physiology going during the three or four minutes until CPR was begun at the surface. In any case, three cheers for all the people involved.

CASE TWO

The next is perhaps the most magnificent case that I have ever heard of. It concerns a diving casualty in 1977 in Sequin, which is a small island in the West Indies. A 23 year old Negro male, who was physically fit, went diving for lobster, as had been his custom for the past seven years.

At 7.30 am with a single 72 cubic foot tank on his back, with neither depth gauge or watch, because he had not heard of these, he dived to about 90 feet (his own estimation), looking for lobsters. He stayed down for about fifteen minutes (again estimated), surfaced, using no decompression schedule, which indeed, according to the tables, he did not have to. He rested for three or four minutes and then repeated the dive. He would have had 20 minutes "residual nitrogen time" when he came up, so he went down already over the limits of a no-stop dive.

He repeated three such dives, with a surface interval of about three to five minutes between each dive. He was obviously a very careful fellow, because on the third surfacing he rested for seven minutes, feeling that if he rested twice as long, he would probably be alright. So in all he made approximately four dives to between 90 and 110 feet, with bottom times of approximately fifteen minutes each. I tried to follow this in the tables and lost it after the second dive.

As he was surfacing from the fourth dive, a large fish attacked him. He threw caution, but not his lobsters, into the water, and made for the surface as fast as possible, holding his breath. He escaped the fish, he also escaped the air embolism, but it was not third time lucky, it was fourth time unlucky as he did get decompression sickness.

He came ashore having got enough lobsters. After fifteen minutes ashore, he developed chest pain. This was at about 1130, about three hours after he commenced this escapade. He decided, being a very astute person and knowing all about medicine, that as he had chest pain, he had better get back into the water. So he took himself down to 50 feet, with the purpose of recompressing himself. Strangely enough, on surfacing, there was no relief.

We next hear of him at 1600, about five hours later. He was still on the beach, obviously not feeling 1OO%. The next phase was that the pain in his chest got worse. He also developed pain in the abdomen, in the ankles, hips and knees, numbness of the legs and lower back pain. He was however, mentally alert, so he put on his tank and went down to fifty feet again to try and recompress himself.

On surfacing again, there was still no relief, so he did as all good divers do, he went home to bed. Around midnight he was awakened with severe chest pain, tightness across the abdomen, severe weakness of both lower limbs, numbness and paraesthesia of both thighs and legs, inability to micturate and vomiting. He also had low back pain. When he was eventually seen he said that he had "felt terrible".

Around 0600 the following morning, almost 24 hours after the original dive, he went to the neighbouring island of St Vincent, where there is a hospital. He was flown from there, when they realised what the trouble was, to Trinidad, where he remained in the Public Hospital for a further four hours, until some bright spark there made the diagnosis of decompression sickness.

He was taken to the recompression chamber at 1630 and treated on US Navy Table 6a straight to 165, there for 30 minutes, come up to 60 feet and have oxygen with air breaks. The total time is five hours and nineteen minutes. Unbelievably, he got relief of all his symptoms within five minutes at 165 feet. He emptied his bladder spontaneously. The diagnosis of Type II decompression sickness with spinal cord involvement was made. He was given Decadron and examined fully. All his physical signs were normal. There was no neurological deficit. The cranial nerves were intact. There was no loss of sensation, no pulmonary symptoms, nor emphysema. At 60 feet all the physical signs were still normal, but the patient complained of feeling weak, and having low back pain and tightness across the abdomen, weakness of both thighs, pain in the hips and knees, numbness of both thighs and legs, paraesthesia and cotton wool feeling in the feet. The chest pain did not recur.

At the surface these symptoms persisted. So the following day he was treated on table five, which is the oxygen table, and all his symptoms decreased. Table five was repeated in the evening of that same day, the morning and evening of the next day, and the morning of the following day. After each treatment there was a further decrease in his symptoms. After five oxygen treatments the only symptom was tightness across the abdomen. This persisted in spite of further treatment over the next two days.

They then decided to discontinue the chamber treatments as all possible improvement had been presumed to have taken place. He was given Decadron 10 mg daily throughout the whole of that period. The patient was comfortable and happy and was returned to Biquea one week after the accident.

The tightness across the abdomen could possibly have been muscular pain from trauma during the dive, or to use his own words, “Because I had to get to the boat in a hurry”, after the fish attacked him.

This again is a case of totally successful recompression treatment using a table 6a and continued with intermittent use of table 5, of a patient who violated almost every rule of diving and paid the penalty for it, developing decompression sickness with a spinal involvement. He was not treated for some 31 hours after the original symptoms, and probably some 23 hours after the offending episode. If a diver is lucky, treatment can be delayed up to 33 hours and still achieve a good result, but I would not really recommend it.

CASE THREE

The next case is one of my own. It has not been presented before although I had prepared it for presentation when I left the Bahamas to return to Australia. As a result of the move all my notes are inaccessible. This case is very clear in my head, due to the principles involved, although the exact details as to times, specific depths, and specific treatment are not at my fingertips. I think it is the overall picture which is important.

The story concerns two experienced divers, A and B, who with diver C looking after the boat, went for a dive in the Bahamas to a ledge at roughly 120 feet. The dive must have pushed the limits of the table, although they were not at 120 feet all the time, but remember that according to the tables one has to take the deepest depth. They were on the borderline of having a decompression dive.

While they were down at depth, diver B noticed that diver A was in difficulties. When he swam over to him, he saw that A was unconscious with his regulator out of his mouth. Diver B then took diver A to the surface. B was an experienced diver, a diving instructor who ran a dive shop, so he knew what to do. He tried to give his buddy buddy-breathing on the way up, but the buddy was unconscious and was unable to keep a regulator in his mouth. Diver B was very certain that diver A made not one attempt to respire, in other words, he held his breath during the ascent.

They arrived at the boat. The unconscious diver was pulled into the boat, and they thumped him and bumped him and did the right things. He gave a huge gasp and retched and vomited a great quantity of sea water. In a reasonably short space of time he was breathing. It was about a half hour boat trip back and by the time they reached the shore, diver A was fully conscious and a little bit upset that people were making a fuss about him. However, his buddies were reasonably responsible people and they decided that they were going to take him to the hospital anyway. They took him to the hospital where he was admitted and put to bed and treated as a case of near-drowning, partial drowning, incipient drowning, or whatever one likes to call it.

His two buddies, the one who had helped him to the surface and the one who had been in the boat, then decided to walk down the street and have a hamburger and a beer. On the way, diver B, who had brought diver A up, noticed that one of his legs was not working properly and thought that he must have bumped it getting into the boat. So he had his hamburger, then got into a taxi and went back to the boat on which they were living. By this time he realised that one of his legs was not in good shape. So he did the usual thing. He went to bed. This all had happened in the late hours of the afternoon. By the time he decided that something was wrong, and that he needed treatment it was late. Around 2330 diver B presented himself at the chamber.

When I was informed my immediate concern was the fellow in hospital, who was probably sitting up in bed with an air embolism, or at least pulmonary barotrauma. Although he was reported to be normal, I felt that he could not have come up from 120 feet without breathing and not have something the matter with him. So I told them to stick diver B in the chamber on a table 6a. And I went to see the fellow in hospital.

I found diver A sitting up in bed smoking a cigarette and asking when he could go home. I had a look at his chest X-ray and found it completely normal, so I tore back to the chamber to see diver B. By that time my colleague had arrived, so I went into the chamber and he stayed on the outside.

To cut a long story short, we did serial treatments, and there was an improvement over three or four days, but nothing dramatic. He also had Decadron and various ancillary modes of treatment, but he was not benefiting remarkably from any of our treatments and eventually he was sent off to the States where he had an intensive course of physiotherapy. The last I heard of him, he was back to operating his dive shop, back to diving, feeling pretty well, but with some neurological deficit in his leg.

Two questions that arise from this are:

1. Why did diver A, the unconscious one, not embolise, coming up from 120 feet without breathing?

2. Why did diver A, even if he did not embolise, not get bent when his buddy did?

It has been suggested that diver A breathed out before he was found unconscious at 120 feet. It is possible than if he just had residual air, that his lungs would not have inflated to the point of bursting by the time he reached the surface. While that is possible, I prefer another explanation, liquid breathing!

I mentioned that when diver A was back in the boat he vomited copious amounts of sea water. I suggest that for some reason or another, he had a malfunction of his equipment and inhaled sea water. As a result he had two lungs full of sea water, which of course would prevent an air embolism. So here is a new way to prevent someone having an air embolism, drown him first!

Why did diver A not get bent? Perhaps it was because he did not exercise on the way up or in the boat. I think it more likely that some people bend and some people do not for the same exposure. I think that diver B's decompression sickness was just a manifestation of chance.

DIVING ACCIDENTS IN NORTHLAND, NEW ZEALAND

Edgar Johnson

I am a pathologist, so you can imagine the outcome of the cases which I will be talking to you about. However, I do not intend to just discuss a list of tragic misadventures. The reason for giving this paper is to point out one cause of underwater tragedy, and subsequently I would hope to learn the opinion of others.

The northern area of New Zealand is served by two pathologists who come to see all the violent or unnatural deaths. It is about 100 miles to Whangarei, from Auckland, where the Poor Knights islands are offshore, and about 40 miles further on there are the Three Kings islands. There is a population of about 100,000 in this area, jumping in summer to approximately 200,000. Probably the greater part of recreational diving in New Zealand takes place in this Northland area, the reasons being the climate, the clarity of the water and the special attractions.

In 1902 on a calm but foggy day, a cargo-passenger ship was travelling at full speed when it ran slap into a charted rock and sank. The bullion lost ran into millions. Soon after the tragedy, two divers, in an attempt at salvaging on the wreck in 150 feet of water, soon succumbed to a mysterious illness, characterised by muscle and chest pain, subsequently known as the bends, or now as decompression sickness. More recently, about fifteen years ago, Kerry Tarleton began a huge salvage operation which today provides the fortunate diver with the possibility of finding a gold or silver coin in the sand.

Between 1976, when I arrived in Northland, and mid 1982, there were eleven scuba related diving deaths. During this seven year period the national toll was thirty one. But in Northland all these accidents have come through the one centre at Whangarei, I was involved in most, but not all, of the post mortem examinations.

CASE ONE

The first was a young diver who went alone into the water from the beach, from a group of divers. He was found on the bottom in about ten feet of water, with all his diving gear in place. There were no signs of life when he was returned to the beach. At post mortem, his head and neck were blue, and there was filling of his trachea and bronchial tree with the fragments of a very recently ingested meal.

CASE TWO

The next case, in 1977, was due to air embolism, which is the common cause of tragedies of this kind. He was diving from a boat, he surfaced, apparently normally, and waved to his companion in the boat but shortly became very distressed. By the time the companion in the boat reached him he was unconscious and died before being taken to the beach in the boat.

CASE THREE

This man was one of twelve divers on a trip to the Poor Knights Islands in 1977. Following a dive he was noticed to be trembling and a little scared. He was advised by more experienced divers on the boat not to dive if he was anxious. He went over the side ahead of two of the divers. The leader of the party saw bubbles coming up in an area where the water was up to 230 feet deep. The leader immediately donned his gear and dived, but could not find the victim. He was subsequently found about one or two hours later at 220 feet, where he was obviously deceased. When his diving bag was examined by the police, a plastic bag of cannabis was found. Subsequently the blood level of the active ingredients was found to be close to intoxication level. Subsequent examination of lung section, however, brought the conclusion that this man may have inhaled gastric contents whilst diving.

CASE FOUR

Three companions, having completed a dive for scallops, were swimming back to their boat when the first two looked round and found their companion was no longer swimming with them. Just before the disappearance, one of the swimmers thought that their companion was swimming somewhat erratically. He was later discovered, unconscious, but died of drowning.

CASE FIVE

The first case in i980 was, and still is, a mystery. An experienced diver with several year's experience, was diving at the Three Kings, off the North Cape, with two doctors. He appeared to have swum off in a different direction. Subsequently, the others surfaced and realised that he was missing. After a search lasting three quarters of an hour, he was found amongst shallow rocks on the bottom. No reason at the time, or subsequently, can be found for this loss. There was moderate surf running and he had a small minor bruise on his head.

CASE SIX

An experienced diver, with a number of deep dives to his credit, wanted to dive down to a long, deep trench, down to about 200 feet near the Poor Knights Islands and to rise slowly as he progressed to allow for decompression. About five minutes after entering the water he surfaced, obviously in great distress, and became blue, lost consciousness and was considered dead when pulled into the boat. The post mortem showed signs of acute congestion, characteristic of asphyxiation, and there was acute pulmonary oedema. A lot of food fragments were present in his trachea and major bronchii and many of the minor bronchii. The trachea and bronchial mucosa was deep red, another sign of inhalation of gastric contents.

CASE SEVEN

This man presumably ran out of air whilst tying a load of scallops onto his boat. His companions who had previously been diving could see him, but had exhausted their own air supply and could not go to his assistance. The body was discovered the following day, when the air tank was found to be empty.

CASE EIGHT

In 1981, this body was discovered on the sea bed in about 30 to 35 feet of sea water, after having been missed by his companions. He had previously dived only six or seven times in the sea and had had no formal training. The pathologist had difficulty in deciding just how the man had died, since there were a number of causes for the pulmonary oedema, which was the main finding of the post mortem. There was also a degrading of the tracheal and bronchial mucosa. In fact this man had widespread evidence of aspiration microscopically with proteanaceous pulmonary oedema and fragments of vegetable matter in the peripheral lung tissue.

CASE NINE

During 1982, an experienced diver intended to dive at the Poor Knights to a depth of 180 feet. He descended and rendezvoused with his companions at 100 feet, and they then went on to 180 feet. Almost immediately one of the party looked up to see the victim drifting very fast towards the surface. The companion followed and saw the deceased roll over backwards with his arms outstretched and hands quivering. The companion reached the deceased but he had floated down in the water and he could get no response from him. He did note air coming out from his mouth piece. We still have no idea why this man decided to ascend in this manner and then apparently drowned. There were no defects in his equipment and no evidence of pre-existing disease. He was 34 years old and so a heart attack was unlikely. A microscopic search of the lungs failed to find any inhaled material.

CASE TEN

A heart attack did occur in this man, who had severe coronary artery atheromatous disease.

CASE ELEVEN

The final case was hit by a speed boat. The diver had no flag.

COMMENTS

Two of the eleven had obvious macroscopic aspirations where the trachea and main bronchi contained white frothy mucus and numerous vegetable fragments, particularly in the lower trachea.

The main points of difference between someone who had drowned and one who has aspirated can be shown. In drowning there is relatively little interalveolar protein and sometimes it is very congested in the alveolar walls. By contrast, in aspiration, there is oedema and debris within the alveoli. In the case in 1981, who was recovered from the sea bed, there was a mass of material, including partly digested muscle fibres, also small fragments of vegetable cell wall, in the distal airways. There were similar findings in the individual with a high cannabis level.

Surprisingly in the two cases where obvious macroscopic inhalation had taken place there were no small fragments in the distal airways. Nor were any vegetable fragments seen in the many seawater drownings.

Over a seven year period, eleven scuba deaths occurred in which two were obvious aspiration of gastric contents and subsequently two more aspirations were detected. That is about 40% of scuba deaths.

Scuba deaths in our area contribute only about two per cent of accidental or violent deaths. Aspiration is a serious possibility, especially in the less experienced diver who is unable to cope with this previously unheralded or perhaps unthought of emergency.

New Zealand deaths associated with scuba diving, from the period from 1961 to 1973 were reported in a paper in the New Zealand Medical Journal by an Auckland pathology registrar. He examined the inquest details of the 21 cases over this twelve year period. The number of cases per year was roughly the same, which to my mind indicates an improvement since scuba diving has become much more popular in recent years. Nine cases ran out of air. Only in two was aspiration poorly but not adequately described. Often histology was not done. There is a strong indication that the causes of death are changing possibly due to better standards of diver education.

Dr Martin Sher

I have heard before of aspiration being the cause of deaths. I wonder whether it should be part of diving courses to learn bow to cope with vomiting. If you feel like vomiting you should take your regulator out, as vomiting into the regulator and then breathing it back in may be the cause of aspiration. Talking to divers, many of them are not aware that they should take out their regulators, their only though is to get out of the water as soon as they can. How to cope with vomiting underwater should be pushed by the instructors and made known in diving courses.

SALVAGE DIVING

Ian Lockley
Salvage Pacific Ltd.
Suva

Salvage diving is a fairly broad subject. I will confine my talk to the area that we work in. Our base is in Fiji and we branch out into New Guinea, Australia and occasionally to New Zealand. To the east, we go as far as the group of islands south of Hawaii. Most of the diving we do is in warm water. This certainly makes diving a lot more pleasant and enjoyable. Most of it is also in clear water, so we are normally able to see what we are doing. However, we do run into jobs occasionally that go back to my early training days, which were in the Brisbane river. Once you were 1cm under the surface, it was dark and everything was done by the Braille method. We developed several techniques while we were diving like this. One was to use the stainless steel mesh glove used commonly in abattoirs, to enable us to have the tactile sense that is so necessary to perform useful work when you cannot see. As the various senses go, sight, touch, sound, naturally the diver becomes less efficient. It is amazing the number of little things that have developed in the industry, particularly over the last ten or fifteen years, that have enabled us to achieve more and more in a given time.

One of the problems which we run into in this part of the world is that it gets deep very quickly. We have restricted our diving to compressed air, for the simple reason that to become involved in mixed gas diving is very expensive. Also, listening to divers talking, I am quite sure that there is a lot still to be learned about it. It is mainly restricted to oil rig diving, which is very well controlled and where finance is not the first problem. There is also the odd occasion, such as the recovery of the gold from HMS "EDINBURGH" where money was not really a problem once the target was located. The diving on that particular job was really quite straight forward, but it was written up in a book, "The Discovery of Stalin's Gold" as being a fantastic feat. From a professional diving point of view, it was the sort of thing that is done every day on oil rigs around the world. Nevertheless, it must have been a tremendous sensation to be picking up these bars of gold.

Our diving here is largely scuba. We do on occasion use face masks, positive pressure systems, if we are using communications. We find that communications can be used quite well with ordinary scuba equipment if you have someone who has been diving with you as a buddy, as the topside operator. It is quite possible to talk with an ordinary water mike. We leave it dangling and when we want to say something, we put it up near the regulator and somehow squawk out a noise. More often than not, the communication that we want is fairly simple such as "up" or "down" when lifting something, or "on" or "off" when using a hydraulic circuit. Quite often we use surface supply to avoid the problems of putting heavy tanks on and of filling them. It is much easier and cheaper to operate on hookah if we are operating in deep water. By deep I mean below 100 feet. Diving with a hose, we use either an ordinary demand regulator or perhaps full face mask. We also use a small bail out bottle to enable us to get back to the decompression chamber or to make a safety stop and carry out decompression with the air that is on our back.

We try to make our system as safe as possible in that the particular diver who is down there working is entirely responsible for his own safety. He may need support for carrying out the particular task, this is in the form of lifting and hydraulic power. But from a safety point of view, I subscribe to the school that every man should be on his own. So many of the accidents that have occurred have been a third party involvement, where they take the wrong mixture down, or something strange has happened, and that has led to an accident and often a fatality. We have done a little bit of experimenting with the fibreglass helmets that have developed from the original hardhat. We do not use them now. We do not need them for protection. We do not need them from the point of view of safety. If you are going into a particularly tight situation where there is a possibility that you may get hung up, the full face mask is more than adequate. The full face mask that we use is a positive pressure system. What would happen if somebody blacked out with a full face mask like that on I cannot say, because I do not know of any case histories. But certainly it would not be any different to wearing one of the "Rat Hats" as they are sometimes referred to. They are ridiculously expensive to buy. They are expensive to maintain. And all they really use, except for the sophisticated communication system, is an ordinary demand valve. In fact, a lot of them do not even have the refinement of regulators.

The Scubapro Pilot regulator came when we were diving on the "PRESIDENT COOLIDGE" We found the Pilot regulator of immense benefit, particularly as we were working down around the 200 foot level on compressed air. We were sometimes spending an hour and a half or even two hours at that depth. This is in the US Navy exceptional exposure tables. We found it more productive to do one long deep dive each day, rather than shorter dives, with all the inherent decompression and problems. It has always amazed me that they have not introduced Pilot regulators or power breathing into the deeper systems. Some of the modern gas recovery systems for mixed gas diving are good, but still we do not see, to my knowledge, power breathing. We have all had power steering and power brakes on our cars for years. I wonder why we cannot have power breathing, particularly in the commercial world. I think there is an opportunity there for someone to get in and to push power assisted breathing.

We have found when pushing new systems, I think that this applies more to oil rig diving, that people are very reluctant to accept something new. The rig bosses tend to use what they have operated with over the last decade or so and anything new is regarded with suspicion. There is good reason for this. These operations are obviously very expensive and a small problem can sometimes develop into a major one. It is amazing how a small event can be magnified and can stop the whole proceedings.

With our type of diving, on compressed air, we are really limited to the topside of 200 feet. We have done inspection photographic dives down to a maximum of 270 feet. We used an ordinary Nikonos camera and found that they work quite well at those depths, although I would not recommend it. We are lucky in that where we have done this, it has been clear water in lagoon conditions. By lagoon conditions, I mean a calm sea state and very little current. I think that this has a tremendous part to play in compressed air dives. I understand that there is a lot of research going on into compressed air diving, particularly in America. We have noticed that we can perform quite well to that depth to 270 feet if the water is warm and it is clear. But as soon as you change either one of those things, concentration starts to wander and it is very easy to become distracted by the slightest thing. I would suggest that perhaps the clarity of the water, the general ambient light, has more to do with it than the temperature. It is fairly easy to keep yourself warm with hot water suits. If necessary, a hot water hose stuck into a wet suit is a very comforting feeling when you are decompressing and you start to get the shivers, which can happen even in warm, tropical waters. But at depth, I would say light, or the ability to orientate has more to do with success than anything. Some of you may remember that, at the SPUMS meeting in Suva in 1978, one of our divers gave a talk on a bad attack of narcosis at 270 feet. He was one of the divers who had never experienced narcosis severely and, like a lot of us, believed it could not happen to him. He saw lights dancing and could not concentrate and if he had not had someone with him, he probably would have drowned. The other person with him was able to guide him back to the surface. He only ascended a matter of 50 feet before he was completely in control again, and wanted to go down again and continue what he was doing. I think that was probably brought on by physical work. Since then, we have limited our people to photographic surveys.

There have been peculiar things that have happened in very deep water. I have just come back from Aberdeen, where they have taken to filling lift bags with helium. You can imagine what it costs to fill a 10 lb lift bag at 1,000 feet with helium. They were using compressed air for lift bags up until recently. However a bubble of compressed air happened to get under the skirt of a diver's mask and he suffered nitrogen narcosis, at something like 1,000 feet. You can imagine the effect of that. You can also imagine the cost of the other way around.

Our reason for not going into mixed gas, although there are plenty of targets in which we could use it, is one of cost. It is not just the cost of the gas, but the cost of setting up the whole diving system. Today, one would have to spend something like 1,000,000 dollars to buy a good system and this would only be a 800-900 feet system. This would enable us to go after a lot more of the lost cargoes in our area. There are something like 250 merchant ships sunk in the Second World War in this part of the Pacific. We have done some research to turn up the worthwhile recoverable cargoes. We now have a few of these on the topside of 700 feet of water and we are wondering whether we will go with diving equipment, putting man down there, or use remote control to place explosive charges and use grabs and cranes to do the recovery. It is not a very difficult thing to cut a hole in the side of a ship and reach in with a crane grab and lift out the nonferrous cargoes that we are interested in. It has been done before. When the gold was recovered from the "NIAGRA" during the Second World War, they used pieces of water pipe packed with explosives to cut the side out of the ship in 400 feet of water, and then lifted out the gold after removing the door from the strong room. All that was done with a small observation chamber and grabs operated by a little coaster 400 feet above. I think that today using modern technology and integration of electronics and hydraulics and remote systems, it is all quite feasible and can be done economically, but we have yet to prove it.

We have a team of men and equipment. It is a little bit like the fire engine and the firemen situation, we get sick of polishing the fire engine and we look about to see what is worth recovering. We have finished the cargoes in shallow water on the topside of 200 feet. Some of the vessels were wrecked well before we started off operating in the area, but we have worried them over the years to the point where we have now cleaned them up. This is the main reason that we are looking now at deeper operations.

Whether you go to the 200 foot line or to 2,000 feet or in fact to 20,000 feet, the operational problems of remote systems are very similar. It is very easy to get an electrohydraulic power pack down to 20,000 feet of water to perform useful work. It is then easy to send excellent TV pictures from 20,000 feet and to operate manipulators. These systems are a little bit experimental. This was the sort of thing used by the US Navy with the Hughes group of companies, in recovering parts of the Russian submarine. A lot of the technology that is in the oil industry today has developed from that. The US Navy developed a remotely operated vehicle (ROV), an early seeing-eye TV camera. It is operated by nearly every company using mixed gases in deep water. Most of the divers prefer to have one of these flying eyeballs watching them. It gives them an extra sense of security. There is always the old worry of looking over your shoulder to see if you are going to become part of the food chain. These flying eyeballs operate to 20,000 feet just as easily as they operate at 2,000 feet. The electrical and hydraulic systems operate just as easily. There are a few problems with extra depth like the dynamics of cables and all the equipment that is needed to get it through miles of water, but these problems can be overcome if the economics justify it.

The ROV systems have developed to the point where a TV camera can be dynamically positioned with plus or minus half an inch from the surface in many thousands of feet of water. Heading direction can be maintained to an eighth of a degree. The equipment can more or less be bought off the shelf, thanks to the space race. It is the same equipment used to guide the space shuttle. It can be integrated with microprocessors and with a simple joy stick can be controlled by a pilot, who preferably is a diver, to inspect a wreck, or a well head, and to do simple tasks like turning valves on and off, placing explosive charges, and operating the controls of hydraulic manipulators to do large work tasks. It is all feasible and is being done in industry today. A lot of it is still experimental.

Some companies are pursuing ways to keep a man down there under pressure and there is a lot of work being done on that. Others are taking the tack of putting a man into an armoured suit, the JIM suit. I do not think that system will be with us for very long, I think that we are going to see either a breakthrough in medical technology so that man can work successfully below 1,000 feet, or we are going to see completely remote systems. It will be very interesting, from our salvage diving point of view, to see which way it goes in the next decade. In the film that we had taken on the WAIGANI EXPRESS, a lot of discussion was going on with chain caught up in 200 feet of water. We are frustrated by not being able to work in that depth which is really fairly shallow. We have decided at this stage to go with a ROV and ROV remote pilot vehicle, so that we can send a camera down to that depth very easily, deployed from a boat of opportunity, which could be anything as small as a 35 foot workboat. We could send this camera and a manipulator down to 2,000 feet if we wanted to, by quite simply lifting it off the back deck. You cannot send a diver down to 2,000 feet by dropping him off the back deck. We can then use this machine to attach lift bags to heavy weights. We can use it to place explosive charges so that it can cut 3" chain cable, or 3" wire rope. We can then direct the force of the explosion to chop a piece from a coral head in 400 feet of water. I think that modern technology in the form of hydraulics and electronics is ahead of man at the moment.

We have been frustrated because we cannot work in 400 feet of water, but we have found this little machine that we feel we can make do useful work. At the moment, if we do get a chain caught up at 400 feet, we have to go through the problem of manoeuvring a tug at the surface. We then may run into bad weather, such as we experienced on the WAIGANI EXPRESS where we had 100 ton tow lines broken like pieces of cotton and all the problems that they cause. I cannot blame the people working on the back deck who say “That’s enough” when a rope like that breaks. It whips back and tears steel bulkheads apart. You can imagine what it would do to a man, if he were unlucky enough to be in the way.

If we stay with long duration compressed air diving, above 200 feet as we did for the COOLIDGE operation, we have found that it is very successful. When we embarked on that programme, we were just a little bit concerned that we were going to be faced with the incidence of bends (about 3%) that is apparently acceptable to the US Navy. We prepared as best we could with a bell that was attached to the side of the ship and a small transportable pressure chamber. We were lucky enough to have the backup of the Australian Airforce for that transport chamber. It would have gone to Prince Henry Hospital to their recompression chamber if there was a serious problem. In thousands of dives, involving exceptional exposures, we only had one suspected limb bend. We do not think it really was a bend. I think it was more a strained muscle, but we treated it on oxygen with a shallow table, and it disappeared and there were no recurrences. I wonder why we were able to make thousands of dives under working conditions, and not have perhaps a single problem. No one really has been able to provide an answer to that other than we were unconsciously putting in an intermediate stop at approximately 90 feet, because that was the depth at which the chamber tether chains were attached. Unless we happened to work immediately adjacent to that attachment on the wreck, we swam horizontally at a depth of between 80 and 100 feet for three or four minutes along the hull so that we were always in contact with the vessel all the time to the chain. Perhaps that deep water stop, which was not part of our decompression time, was providing that margin of safety. Perhaps there is room for a little bit of investigation there.

I feel that a diving bell is most effective for that type of decompression. I am not in favour of surface decompression routine, although it is widely used. We have found that our divers prefer being able to ascend directly to the chamber. They do not like the thought of jumping out of the water, slipping off as much of their gear as they can and immediately getting into a chamber while someone shuts the door and hopefully turns on an air valve, or even leaves it to the diver himself to turn on an air valve, to repressurise him within 5 minutes of leaving his last stop.

Of course the diving bell, and certainly the surface bell, can only be used in calm, relatively current free waters. It would be impossible to tether a bell in open sea conditions, where there was any surge running, the pressure changes during the last stop at 10 feet would be too great. The alternative is to leave the bell down at 40 feet and decompress on oxygen, then a tethered bell could be used readily. However, a ground swell surging backwards and forwards 15 feet, would make a submerged bell very uncomfortable at 40 feet. Perhaps transfer under pressure is the answer. That system is used for mixed gas diving. But it is expensive. It is cumbersome. It requires a lot of topside support and cannot be deployed from a boat of opportunity, unlike our little ROV system. What we are looking for is the impossible. Being able to jump a man off the back of the boat, instead of throwing our little ROV into the water, and say “Go down and see what the problem is at 2,000 feet and when you have finished come straight back up again.”

Walter Stark developed the Electrolung more than a decade ago. This certainly enabled you to jump off the back of a boat and go down to 600 feet, perhaps more, swim around, do your thing, and come back up again and then promptly die with massive decompression problems. Perhaps gas changes, perhaps different mixtures may solve the problem in the future. Today, we have the pressure sensors, gas sensors, gas regulators, processors that the whiz kids need to come up with a solution to this. Perhaps by gas changing one can eliminate the decompression problem and then it will be possible to jump off the back of a boat.

I think that the decompression problem is the real one. Other than exploratory dives, such as photographic dives or survey dives, we generally go down to perform some work. We take power packs with us. A small power pack today is readily available in the form of surface support from a cable at anything up to several thousand volts to hydraulic coaxial cables, to explosive contained energy. All these are possible, but decompression is not unless we go into the difficult systems, transfer under pressure and deck decompression, but one certainly cannot operate them from a boat of opportunity.

What does the future hold? By the future I mean the next five to ten years. Are we going to see R2D2 robots taking over? With divers operating them? There is a lot of money being spent at the moment on training pilots for this magical little machine. It is my opinion that they need to have come from the commercial diving world to make a good pilot. How you can project yourself into one of these little machines, down at several thousand feet, and then do useful work is a little bit beyond me. But with these force balanced dynamically positioned systems, with master manipulators it is possible. The integration of these systems is still experimental. Perhaps someone will come up with the magical solution to the decompression problem. I am quite sure that electronics are going to play a major part, because under situations of stress, even our computer tends to break down and make mistakes, and I think that leads to more accidents today than anything else. The push from surveying the various operations around the world is towards machines and not man in the sea. The other school, which appears to be the minority at the moment, are saying “Keep man down there”. Only the future will tell.

In our thirteen years of working in a difficult and hostile environment, quite often from boats of opportunity and in places of opportunity, all the accidents that have occurred have been the people factor. We have never been able to explain why somebody, who is experienced, has done a silly thing. Quite often at times that are not apparently of any stress, people have run out of air, when they have had backup systems, when they have had buddies diving with them. They have been diving with communications and suddenly the communications have gone dead for no reason. I think this is one thing that we cannot eliminate, the people factor. I feel sure that even if we are able to solve the problem of decompression, so that we can jump off the back of a boat of opportunity, like our little machine, that we are still going to have a little machine following us. Perhaps the diver is going to be telling the little machine what to do. After all, how many watts of power can we produce for any given period of time compared with what a machine can do? I think this gets back to our power breathing, power brakes, power steering. I think that is the way that the oil industry will be going, and I am quite sure that is the way that we will be going in our salvage diving.

LETTERS TO THE EDITOR

PO Box 79,
NAPIER 4000,
New Zealand

Dear Sir,

The factors affecting the advisability of contact lens use vary as widely as the types of diving, and a blanket rule against contact lens usage in diving as suggested in the January to March 1983 SPUMS Journal is rather an over-reaction.

I certainly agree that contact lens wear is never acceptable in saturation or chamber diving. Anything, such as a contact lens, which could possibly affect or reduce the corneal integrity, allowing the possible entry of pseudomonas, which is such a familiar inhabitant of chambers, cannot be permitted. A pseudomonas infection can result in the very rapid destruction of the cornea, the risk of which is not acceptable in any situation, let alone under the limitations of a chamber or offshore environment.

Simon and Bradley's complete paper on the "Adverse Effects of Contact Lens Wear During Decompression" is an extremely interesting paper because, as far as I know, it is the first time that slit lamp microscope observation of the cornea has been utilised during hyperbaric or decompression procedures.

The point that the unfenestrated PMMA (hard) lens caused bubbling in the pre-corneal tear film is not totally convincing in such a limited study. The fact that no details of the corneal or lens variables are quoted in the original paper unfortunately reduces the value of the study.

There are many different techniques of fitting these lenses, each of which involve a slightly different relationship between the lens and cornea. Some techniques require fenestration (holes in the lens) for adequate corneal ventilation, whilst others offer adequate oxygenation and ventilation by other means.

My own work at the USAF School of Aerospace Medicine confirmed that there are no changes in corneal curvature under pressure so any physiological changes during diving will be related to ventilation (ingassing and outgassing) and not because of any mechanical change in the fitting relationship between the lens and the eye.

A convincing and valuable conclusion of Simon and Bradley's paper, however, is that lenses fitted for diving must have good ventilation. We must remember that this can be achieved by other means in addition to fenestration, particularly including the use of the new oxygen permeable materials.

I am not necessarily convinced that the bubbles in the pre-corneal film had to be nitrogen. As the cornea was oedematous, it could well have been carbon dioxide.

A recent Swedish study investigates the adhesion of contact lenses to submerged eyes. There is no doubt that hydrophyllic (soft) lenses have vastly superior adhesion and are far less likely to be lost. Right from the early days of hydrophyllic lenses we have known that in fresh (hypotonic) water, adhesion was so great that forced removal could actually pull away the corneal epithelium. Lövsund's group found additionally that adhesion was sufficient in seawater.

For sport and light commercial diving, I cannot find any studied arguments against soft lens usage.

I also feel that the use of hard contact lenses is permissible in normal circumstances. Realistically both types of lens are not likely to be lost during normal diving activities, but it must be understood by the wearer that hard contact lenses do not possess the same adhesion as do soft lenses.

The reservations that I have with hard lenses, therefore, pertain firstly to someone with a high degree of ametropia who, in the unlikely event of both lenses being lost, was unable to find his way, operate his instruments, or find his boat or entry.

Equally, someone undertaking diving activities that present high risk of mask loss such as could occur in some rescue, military, or police diving activities, should not wear hard lenses.

Yours faithfully,
Quentin Bennett

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TOXINS OF SOME VENOMOUS SEA CREATURES

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A great many sea creatures possess venoms with which they immobilize, kill and tenderize their prey, with which they defend themselves or which they passively accumulate by feeding on smaller species. Human envenomation is seldom, if ever, a result of unprovoked offensive action on a sea creature's part and is much more commonly a result of accidental contact.

A recent review (1) recorded 68 known species found in Australasian waters which possess neurotoxins (that is, toxins which produce their effect by acting on the nervous system and often result in paralysis) but of these very few are capable of injecting enough toxin into an adult human to produce important effects let alone muscle paralysis. There are, however, a few species which produce a high proportion of all serious and sometimes lethal envenomations and these will be mentioned individually below.

This brief review looks at the way in which some of the venoms produce their clinical effects, the characteristics of envenomation by creatures whose toxins may be lethal to man and concludes by examining factors which combine to determine the effects of envenomation.

For a thoroughly comprehensive treatment of these subjects, there is no source better than the newly published Australian Animal Toxins by Straun K Sutherland (published Oxford University Press, 1983; price $100.00). This is well illustrated and eminently readable. Unfortunately, the price is a disincentive to purchase!

HOW TOXINS WORK

The detailed characterization of toxins from marine creatures is a continuing process and new information appears each year. Our present understanding of these chemicals is, at best, incomplete and there may be many more modes of action than we currently recognize. The classification below is not exhaustive but covers most of the important ways toxins may affect us.

TABLE 1

TYPES OF TOXIC RESPONSES TO THE VENOMS OF SEA CREATURES

Allergy - immediate - anaphylactic response
- delayed

Neuro- (or myo-) toxicity often resulting in paralysis or disturbance of feeling

Impairment of Functions of the Blood eg. clotting or the ability of red cells to carry oxygen

Tissue Digestion breakdown of muscle or other tissues, often with the release of substances producing their own damage in turn

Pain

Allergic and Allergy-Like Responses

Allergy occurs when the injected venom contains a (normally) protein substance (antigen) to which the body makes, or has already made, an antibody. The antigen and antibody recognize each other, react together and may cause, as an immediate result of the interaction, the release of powerful substances from some of the body's own cells which in the extreme can lead to a profound fall in blood pressure and severe, sometimes life-threatening narrowing of the air passages with swelling of other tissues. This immediate hypersensitivity reaction is called anaphylaxis and may account for the stories of occasional envenomations resulting in very rapid death, although in general, these are poorly described.

A longer term allergic response occurring in weeks rather than minutes may lead to the laying down of antigen-antibody complex in tissues, and particularly in small blood vessels, and thereby impairing the functions of those tissues - a delayed hypersensitivity reaction. There is some presumptive evidence that this may occasionally occur after envenomation

However, many marine creatures possess venoms which contain the chemical, histamine. and other substances which can directly release histamine from the cells of the human body which contain it. As histamine is released during an allergic reaction, the injection or release of histamine mimics a hypersensitivity response and may have the same consequences. The same fall in blood pressure and narrowing of the air passages that may occur in immediate hypersensitivity can be reproduced by injection of histamine, while minor envenomations confined to the skin (eg. the stings of many marine species) produce characteristic weals - raised areas which itch - are normally painless but which commonly become infected when bacteria are introduced to the area during scratching. Similar weals can be reproduced simply by injecting small amounts of histamine into normal skin.

Nerve and Muscle Toxicity

It is not surprising that slowly moving sea creatures need to immobilize their prey and have toxins which rapidly cause paralysis. What is surprising is the variety of toxins that exist which act at many different points in human nerve and/or muscle to produce this effect.

Each voluntary muscle in our body possesses a particular nerve running to it which transmits information from the brain by way of small electrical currents which pass rapidly down the nerve - the nerve impulse. At the nerve endings, the current induces the release of a chemical, acetylcholine, which moves rapidly out of the nerve and on to a specialized part of the muscle surface where it reacts with a receptor molecule. This reaction leads to muscle contraction.

The electrical current which passes down the nerve is associated with the movement into the nerve of sodium and calcium ions and the outward flux of potassium. Restoration of the nerve to its resting state is accompanied by the pumping out of sodium ions and inward movement of potassium. Interrupt this whole sequence at any point and paralysis results.

These concepts are illustrated in Figures 1 and 2 which also show the probable main sites of action of some important toxins. For example, tetrodotoxin, identified as a major toxin from the blue ringed octopus, Hapalochlaena maculosa, only in 1978 (2), is known to block the sodium channels in nerves and thereby prevent the passage of the electrical current. It is possible that the cardiac poison of Chironex fleckerii, the box jellyfish or sea wasp, may act at the same site. However, the venoms of many sea snakes contain erabutoxins, a group of toxins which interfere with the linkage of acetylcholine with its receptor. By contrast, worm- and fish-eating conus shells appear to produce a myotoxin, ie. a substance acting directly on muscle without interfering with nerve function. The end-result of all these toxins is paralysis but the intimate mechanism differs.

Impairment of Functions of the Blood

The two most important reactions of injected toxins on the blood itself are the stimulation of blood

FIGURE 1

ESTABLISHED AND POSSIBLE SITES OF ACTION OF NEUROTOXINS FOUND IN VENOMOUS SEA-CREATURES

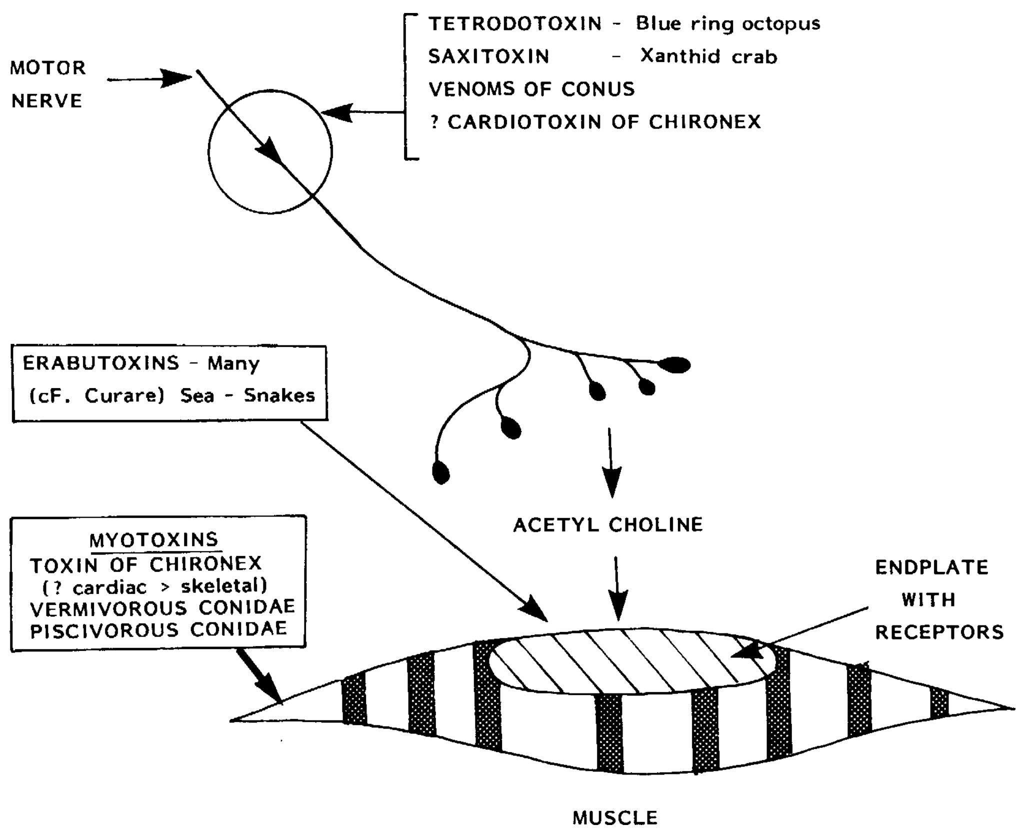
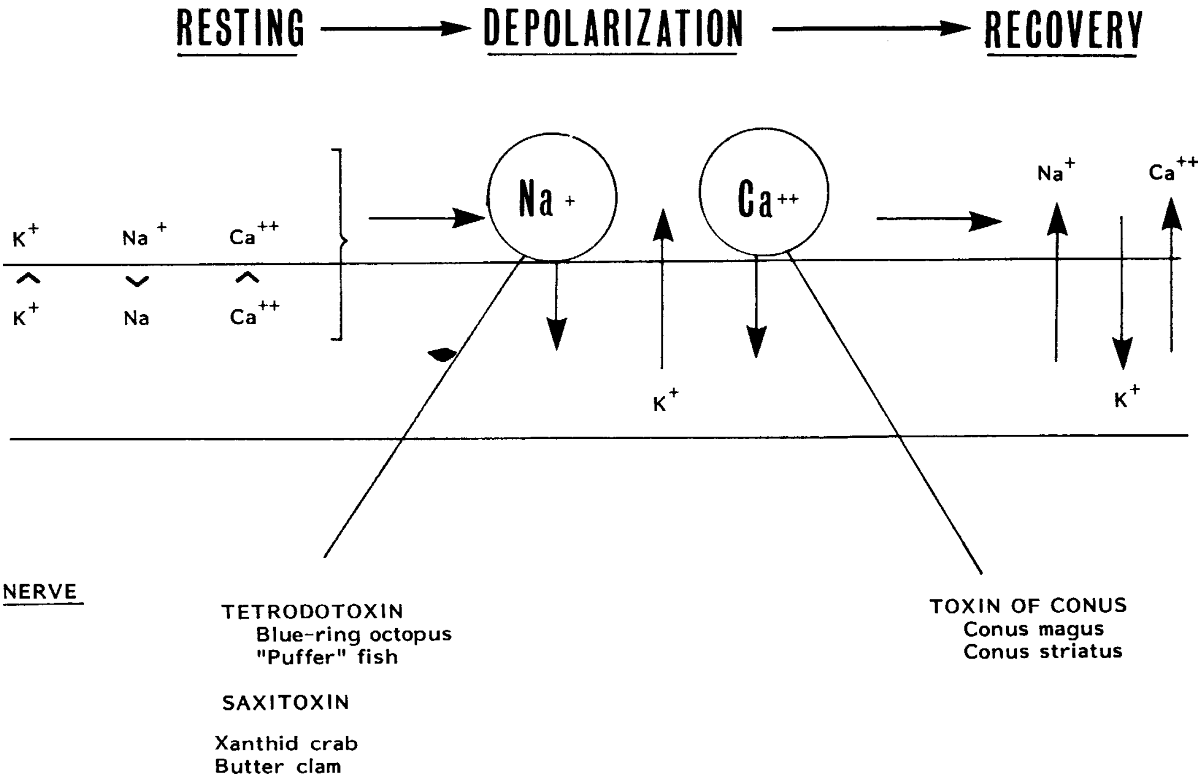


FIGURE 2

SITES OF ACTION OF NEUROTOXINS WHICH BLOCKTHE TRANSPORT OF SODIUM OR CALCIUM IONS



These blocks interfere with nerve depolarization with consequent paralysis. The figure represents a nerve axon during the resting phase, the phase of depolarization and the phase of recovery.

coagulation and the breakdown of the cell membrane of the red blood cells (haemolysis). Both of these actions are well recognized and prominent effects of envenomation by, for example, many land snakes but are also a feature of bites or stings by some marine species though seldom giving rise to serious clinical effects.

Effects on coagulation promote the conversion of circulating fibrinogen to fibrin which is laid down in smaller blood vessels. Blood platelets adhere to the fibrin deposits, red cells are damaged in their passage through the deformed blood vessels and fibrin, broken down by circulating natural enzymes, produces degradation products which are readily detectable in blood and urine and have anti-coagulant properties of their own. The clinical result is a patient, commonly bleeding from many sites, who has low plasma fibrinogen, low platelet count, many abnormal red cells in the circulation and sometimes impaired small vessel function particularly in the kidney. Ironically, but logically, the treatment includes the administration of heparin, another anticoagulant which, by activating anti-thrombin III, inhibits the conversion of fibrinogen to fibrin which is catalysed by thrombin and encouraged by the toxin.

Haemolysis or, red cell breakdown, may occur as a secondary event to the coagulation process described above. Alternatively, some creatures (sea snakes, box jellyfish) do possess a specific haemolysin, a toxin which damages the red cell envelope ultimately disrupting it and leading to loss of contents. Records suggest that this, though commonly present in envenomation is rarely an important aspect of the total clinical picture.

Tissue Digestion

Again, it is not surprising that creatures which have immobilized their prey using a neurotoxin also possess enzymes capable of producing tissue digestion as the first stage in incorporating the captured species into their own body tissues. Many creatures, therefore, inject as part of their venom these enzymes which may cause tissue destruction of differing magnitude in man. Stings from the tentacles of box jellyfish are not only extremely painful but also set up severe reactions in the skin which may lead to skin necrosis and ultimately severe scarring as a result of the healing process. Perhaps the most spectacular example of tissue digestion, however, is afforded by the sting of the stone fish which initially is invariably extremely painful, but, in the absence of antivenene, progresses over a period of two or three days, to produce quite massive tissue loss usually in the foot as the dorsal spines of this fish commonly penetrate the sole of the foot of the unwary. Many of the clinical records of envenomation by stone fish describe a short and extremely painful course of pain, prostration and even of local paralysis (the species possesses a neurotoxin) followed by a prolonged period in hospital during which tissue death followed by reconstructive surgery is a common feature. An interesting aspect of this form of toxin is that it nearly always to act locally in contrast, for example, to neurotoxins which clearly may be transported through the body, presumably via the circulation, and produce paralysing effects at sites away from the point of envenomation itself.

Pain

In the course of the past ten years our concepts of the mechanisms of production of pain in the body have been clarified considerably by the discovery of new pain pathways within the nervous system and by the realization that many substances normally present in the body may, if present in abnormal amounts, induce pain. Substance P, a small polypeptide, bradykinin and several of the prostaglandins may be concerned with the normal transmission of pain and certainly increasing quantities of prostaglandins and bradykinin at a site of inflammation may be the main mediators of the pain associated with that condition. It has not been possible to identify with any certainty the pain producing toxins within many of the venoms of sea creatures but certain species apparently inject bradykinin and some related peptides have been postulated as a cause of severe pain in some envenomations. Perhaps the severest pain ever encountered in envenomation result from the venoms of the stone fish and the box jelly fish. There are many accounts of normally stoical people becoming delirious with pain following envenomation although not necessarily suffering any of the life-threatening consequences of the other toxins injected by the animal. It is perhaps most important to recognize that the pain following a bite or sting is not a good marker of the possible adverse consequences of the envenomation representing, as it does, the reaction to one or at most a few chemicals injected which in themselves have no lethal potential. The bite of many sea snakes and of the blue ringed octopus may be so innocuous as to occasion little notice. Nevertheless, envenomation with lethal quantities of toxin may occur. Equally, the severe pain resulting from exposure to the sting of the sea wasp may not necessarily be associated with the introduction of large quantities of the toxin acting on the cardiovascular system.

One further point needs to be made about these different forms of toxin. The time course for the development of symptoms following envenomation may be very different for each form of toxin. Anaphylaxis is virtually immediate, neuromuscular paralysis takes seldom more than 30 to 40 minutes to become apparent, whereas changes in the function of the blood may require 24 to 48 hours to be fully developed and tissue damage will occur over a period of days. Furthermore, not all of the effects of envenomation are directly related to the toxins injected. Tissue digestion will release substances, eg. myoglobin, which may produce their own secondary effects. In the case of muscle breakdown and the release of myoglobin, renal failure may follow a few days after the initial damage has been done to the muscle itself.

SPECIES WITH POTENTIALLY LETHAL VENOMS

Relatively few creatures have the capacity to cause fatal envenomation in man and some of the factors determining outcome are discussed in the final paragraph of this article. However, it is clear that four species stand out from all others as the most dangerous. Well-attested deaths have occurred following stinging by the box jellyfish/sea wasp which frequents particularly the tropical waters around our coasts, deaths have occurred in otherwise very healthy people bitten by the blue ringed octopus and occasional fatalities have followed the injection of venom from stone fish or from envenomation by various members of the genus Conus. Both the stone fish and sea wasp commonly produce painful envenomations and there is little doubt that the victim needs urgent attention. However, in the case of the blue ringed octopus, and to a lesser extent, the Conus, the puncture may be relatively painless and the first symptoms developed may be those of progressive paralysis. An awareness of what may have happened in these circumstances should alert divers to the possible need for support of respiration and urgent transfer to hospital.

INGESTED TOXINS

Not all poisonings by venomous sea creatures occur as a direct result of injection of toxin into the victim. Many forms of puffer fish contain large quantities of tetrodotoxin in their livers and eating these fish may result in fatal poisoning. Remarkably, cooking the creatures seems to offer little protection and the toxins appear to be heat stable.

DETERMINANTS OF THE EFFECTS OF ENVENOMATION

It is practically impossible to predict the likely outcome after a bite or sting from a venomous sea creature. Many variables will determine the outcome including the amount of venom injected (which may in turn depend upon the season of the year), the route of envenomation (as symptoms are much more likely to occur early after intravenous injection or injection into a very vascular area), the size of the victim (as a little venom goes a long way in a small person) and, of course, the state of health of the person envenomated. It is clear that a large amount of venom injected into a small person whose health is already compromised in some way is more likely to produce serious illness than a small amount injected into a large and healthy person.

The adequacy of immediate treatment may be a major determinant of outcome, however. While antivenenes are available for stone fish and sea wasp stings and for some at least of the venoms of the many Conus species, no antivenene is available for the bite of a blue ringed octopus. Clearly, the envenomation is likely to occur a long way from a handy store of antivenenes so first aid measures and a recognition of the potential severity of the problem will determine the outcome. It is clear from many reports in the literature that the wearing of protective clothing will afford much protection from jelly fish of all sorts, that the use of acetic acid to remove intact tentacles or portions of tentacles is at least as effective, and much cheaper, than the use of proprietary solutions and that rapid transport of the victim to hospital where appropriate observation can be undertaken is mandatory. For most forms and consequences of envenomation there is plenty of time to initiate appropriate measures away from the marine environment. In the case of rapidly progressing paralysis however, such as follows the bite of a blue ringed octopus, it is clear that the early recognition of symptoms of muscle weakness coupled with the ability to maintain respiration by, if necessary, mouth to mouth resuscitation should prevent the tragic deaths which have occurred. All the evidence points to complete recovery being possible if support of ventilation can be provided for a period of a few hours. (3)

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This paper was presented at the joint meeting of SPUMS and NUMBS (Newcastle Underwater Medicine and Barotrauma Society) at Nelson Bay 30 April 1983 to 1 May 1983.

REPRINTING OF ARTICLES

SPEAKING PERSONALLY: RECOGNITION AND MANAGEMENT OF APPREHENSION IN RESORT DIVERS

Steve Hills

First some background to these observations. For the last one and a half years I have been employed at a dive shop in Port Vila, Vanuatu as an instructor/guide for visiting tourist divers (mostly Aussies or Kiwis). We dived two or three times every day under ideal tropical conditions of warm (21°-27°C), clear (average 25 metres) water, although depths sometimes necessarily reached a maximum of 37-38 metres on some of the excellent wrecks. Average depths however were commonly shallower than 20 metres. Decompression dives were avoided. The group of divers assembled on the boat on any one day would typically be a mixed bunch ranging from visiting instructors through divers with no formal qualifications but many years of actual experience eg. abalone divers, to recently certified novices and also the very rusty, but qualified diver. On occasions when circumstances permitted there would also be student divers on the dive or holiday makers attempting the openwater segment of their one-day introductory scuba course, following their morning pool and theory session.

This daily "pot-pourri" of scuba divers presenting themselves at the dive store would be screened, to the best of our ability, for the suitability of the proposed diver.

Of necessity, incidents will occur in this type of daily routine where certified divers are completely unknown to us and the diving conditions are normally quite different to what they are used to, and were trained under. To date our safety record has only been blemished once - a Japanese honeymooner jumped out of a tree and fractured his ankle! (So as not to lose face however, he assured everyone as to his good health, donned his fins and then completed his dive!)

However, it is the almost daily occurrence of small incidents that did not turn into accidents that should be of concern. Because the regularity of these incidents is sufficient to fuel daily staff post mortems as to the success, or otherwise of each dive, we now recognise that a problem exists, and one which if not treated correctly, could lead to a fatality.

Many of these 'incidents' concern apprehension or panic. This condition may manifest itself in a variety of conflicting ways, making early detection not always possible. Apprehension always precedes panic and has been observed in one or more of the following behaviour patterns, by afflicted divers:

- inability to absorb information from a dive plan;
- prolonged questioning about proposed dive;

- gearing up incorrectly;
- defiantly rejecting offers of assistance in preparing for dive;
- slow, deliberate, methodical gearing up;
- reluctance to enter water after gearing up;
- a tendency to begin offering excuses for a possible unsuccessful dive (ears, sinuses, stomach upset), well before arrival at the dive site.

These are all pre-dive clues. An apprehensive diver not exhibiting any of the above pre-dive behaviour patterns may be detected underwater by one or more of the following:

- an over-dependence on the descent line and reluctance to be physically detached from it;
- use of the "something's wrong" hand signal quite soon after leaving the surface. (On checking the problem back at the surface the affected diver will commonly invent a problem relating to his equipment, "This regulator doesn't seem to be giving me enough air", etc);
- use of the "something's wrong" signal but reverting to the "OK" signal on checking closely with diver.

Most incidents of apprehension manifest themselves in one of the above ways, very early in the dive. Occasionally through a diver will pass through the earlier stages of the dive successfully only to degenerate into a situation of apprehension and panic later on. These cases are more serious as they occur <u>during</u> the dive when the victim is away from the back-up facilities and security offered by the dive boat.

Typically these situations begin with the diver entering a "worrying" phase where some problem (or perceived problem) begins to totally occupy the diver's mind up to the point where almost all external stimuli are excluded. This "worrying" phase develops towards panic as a sense of urgency surrounds the problem in the diver's mind. It is about this time that rational thought and behaviour patterns begin to break down, as commonly the diver is overwhelmed by a need to get himself out of his predicament at all costs, sometimes involving removal of his mask and regulator or a rapid ascent out of the foreign environment to the surface, or both.

Again, it is typical for the breathless diver back on the surface to try to rationalise his behaviour thus, "I just couldn't seem to get enough air!" All sorts of equipment malfunctions are cited, but rarely verified back in the workshop.

It is quite unusual for the diver to honestly identify his problem, as peer pressure on a boat full of other successful male and female divers prevents him from doing this. I have only ever encountered one diver who admitted to panic during a dive. Surprisingly, this diver, towards the end of his ten dive package, panicked and then sat down and openly discussed the problem with others on the boat. He had experienced some vertigo on leaving the bottom, panicked, then taken out his regulator and done a free ascent.

To all of us wizened readers, this diver's response to his panic was deplorable and goes against all training. In a foreign environment we depend on our life support system. Why would a diver willingly deprive himself of this support?

Well, having experienced a situation of extreme apprehension verging on panic underwater myself, I can claim to understand that situation, but not explain it. In my own case, I am sure it was only the familiar surroundings of a well-known wreck that prevented my incident from turning into panic at 30 metres, with possible dire consequences. Having just recovered from a chest cold I was back at work guiding three other divers around a wreck, at 30 metres. Fourteen minutes into the dive I started thinking about slowing the ascent at the end of the dive, as a concession to the depth of the dive and my recent chest cold. Pre-occupation with these thoughts developed into anxiety, as for some inexplicable reason a sense of urgency surrounded this need to ascend. I became overly introspective as the sound of my own rapid heartbeat thundered through my ears and I could hear voices screaming through my head to "get out of here"! Training told me to slow down, control my breathing rate, hang on to something solid and get control of myself. In attempting to do something along these lines I must have looked peculiar swimming along tightly holding on to the closest solid object my own mask! I distinctly remember feeling an understanding for those panic-stricken divers who try to rip off their masks and regulators. I guess in a threatening situation any constrictions around the head area are seen as contributing to that threat and need to be discarded.

Fortunately, with many previous dives in that wreck, I knew the exact direction and distance to the mooring chain. Using every possible reserve of self-control I managed a controlled swim to the chain where I had something tangible and secure to assist in my regulated ascent. Without this familiarity with my underwater surroundings, I am not so sure this anxious situation would not have deteriorated into uncontrolled panic.

This was an isolated experience which occurred after many hundreds of hours underwater experience at a familiar depth and on a familiar wreck. I am not claustrophobic and normally experience some narcosis at greater depths than on that dive. I feel sure the incident was initiated by a concern over the consequences of diving deep after a chest cold. But I am glad to have experienced it! It helps me empathise more with other divers displaying pre-dive anxiety symptoms and I find that a discussion of their feelings along with an assurance of close proximity during their dive helps alleviate much of the pre-dive worry that could develop into panic.

Having detected an early warning sign (as listed earlier) the key to reducing the effects of anxiety so as to lessen the risk of underwater panic, lies in the quality of the staff. Our attempts to defuse possible panic situation normally include:

Most importantly, a very obvious display of safety back-up equipment and a pre-dive briefing. Rather than highlighting the potential dangers of the dive, if done correctly this should provide the comforting realisation that the diver is in the capable hands of a safety conscious operator.

Provision of a compatible diving buddy from the staff guides/instructors

Unhurried approach - entering the water last allows the nervous diver (and guide) to proceed at his own pace and not under the scrutiny of other divers.

If anxiety is heading towards a critical level underwater, no single action is more calming and reassuring than that of human contact. Unless the victim is already gripped by panic, comfort will be given by a firm hold on his arm and strong eye contact, both of which impart the feeling that the sufferer is not alone down there. This simple action followed by an exchange of “OK” signals has steadied many an uncertain situation underwater. If however, the victim is beyond the “point of no return” it would be unwise to make oneself available to the wild clutches of a diver who has lost all self-control. Fortunately these predicaments are rare as anxious moments are usually defused before this stage. Two incidents only, spring to mind. In the first the instructor made the rapid ascent alongside the panicking diver and only ventured close enough at about 3 metres to ‘punch’ the victim in the stomach region to successfully force an exhalation of air from the lungs. He was then on the surface with the diver to provide continuing support. The second incident involved a panicking diver’s refusal to return a regulator during a buddy-breathing ascent. A second instructor was alert enough to cover the required distance and provide buddy-breathing support to the first instructor. Subsequent to this incident (some years ago now) all staff now dive with octopus regulators.

To conclude with some of the more pathetic anecdotes in this collection, there was the elderly gentleman on his first open water dive after qualifying, whose body shook uncontrollably with fright so that he was unable to adjust his manual inflate BC and had to be helped from the water (he was reportedly learning scuba diving and hang gliding while he was still alive!). Then there was the ridiculous sight of an instructor surfacing while securely caught in the vice-like scissors-grip of the panicking student’s legs around her torso. And finally, the vision is still clear of the mascara-eyed woman who adopted the foetal position while clinging nervously to the shot line for 20 minutes at 2 metres under the boat, persevering because it is currently fashionable to be able to claim that one is a scuba diver.

SPUMS ANNUAL SCIENTIFIC MEETING 1984

Next year’s ASM will be held in three parts.

April 7th to 14th
at Phuket Island Resort, Thailand.

April 14th to 17th
at Bangkok, including a combined Conference with the Royal Thai Navy.

April 18th
At Hong Kong, where there will be a meeting with local and SPUMS speakers.

The guest speaker will be Surgeon Captain RR Pearson, who is the Royal Navy’s senior diving medical officer. He will be speaking at all three meetings. His topics will be:

- Oxygen, the diver’s friend or foe?
- The problems of caring for sick or injured divers in compression chambers.
- Medical screening of professional and recreation divers.
- Dysbaric osteonecrosis, is it a major problem for divers?
- Saturation diving, a review of military experience and associated research.
- The management of divers with audiovestibular problems.
- Presentation and diagnosis of decompression illnesses.
- Arterial gas embolism in diving and in clinical practice.
- The deep trial unit and the Admiralty Marine Technical Establishment (Physiological Laboratory) (AMTE PL).
- The Institute of Naval Medicine and controlled atmosphere research.

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 these in a presentation suitable for photo-reduction direct. Books, journals, notices or symposia etc., will be given consideration for notice in this journal.

I AM A HANDICAPPED DIVER

John Poteet

Before I talk about my own experience with scuba there is a point I must make, that it is common for people to make all-inclusive generalisations about anyone with any kind of disability. For instance, I was talking to a diving instructor and the subject turned towards the Handicapped Scuba Association (HSA). He made the comment that he would be "possibly" interested in working with the handicapped but he did not know enough about them. His assumption was two-fold, I believe. First, that in order to deal with *the handicapped* he had to gain some kind of new insight about a special group of people from a strange new world. He almost unknowingly placed more emphasis on the DIFFERENCES of people than their similarities. Second, he voiced no awareness of the fact that an individual's ABILITY to undertake a specific task depends on the nature of his disability and the extent of its severity. With no malice he lumped *the handicapped* in one big club and assumed that we would all perform the same way. He assumed that he would be dealing with a handicapped group, not a group of individuals.

I hope that nobody who reads this makes the same mistake. I can only relate my personal experience and this cannot be interpreted as common to all persons who have a disability. In fact even though I have cerebral palsy my thoughts should not be judged as relevant to all other persons with cerebral palsy. As a matter of fact there are six different kinds of cerebral palsy and the severity of the disability within each group varies greatly. When you throw in other variables such as temperament and maturity it should be apparent that stereotypes are not realistic.

Having said this, I can begin to talk about my own experience. Cerebral palsy results from damage to the part of the brain which regulates muscular activity. In my case the damage was caused by a lack of oxygen to the area of the brain called the motor cortex. This occurred because of complications during a premature birth and resulted in spastic paralysis, primarily effecting my lower extremities. Another area of my brain that sustained damage was the cerebellar area which controls balance. Without the aid of forearm crutches I fall down a lot. There is pretty much a full range of movement of my upper limbs, although I do not have the dexterity to manipulate a keyboard or play chords on a guitar.

So how does this effect my diving? First things first. Since my legs are already stiff, putting a wetsuit around them makes them that much stiffer. Combine that with the weight of a tank, back pack and weight belt and moving on dry land becomes a lot more tiring. My solution is to put the gear on as close to the water as possible (except the suit) and to take it off as soon as possible after the dive.

Another problem on one dive was COLD. It was in November and I had an ill-fitting rented wetsuit with no hood, booties or gloves. The water was miserably cold and I seemed to stiffen up like a board. The next week I had my own suit, etc., and the dive went fine. Also on the previous dive the mask I had was continually flooding, so I now got a mask which fitted properly. I also switched from a nylon weight belt that had a tendency to become loose to a rubber belt that fitted snugly. What I have mentioned so far goes for any diver: getting equipment that is comfortable and fits makes diving a lot easier.

With the gear on and in the water I had a couple of problems to solve. The weight of the tank made it difficult for me to move from lying on my back to rolling over onto my stomach on the surface. This was a problem I had not expected and I am still not 100% sure why it exists. But in trying to figure it out it occurred to me that when I roll over in bed, or even on the floor, I use my arms automatically to pull on the side of the bed or to push off the floor. In the water there is nothing to grab onto or push off, especially at the surface. It made sense that if the muscles in the lower back and legs are stiff it may be a lot more difficult to overcome the weight on your back to roll over, especially if the buoyancy compensator is partially filled with air. A partial solution is to adjust the weights in the belt so that they are placed towards the front and counteract the weight of the tank. A similar problem is getting vertical on the surface from a prone position. If there is minimal movement in your legs they will have a tendency to want to stay at the surface. Again, it is hip and lower back muscles that force them towards a down position. Strapping 2 lb weights to each thigh reduces the tendency of my legs to float and helps me to gain an upright position. It is much more practical to put the weights on the front of each thigh than on the ankle because I have only a minimal kick and a weight on the ankle would make kicking much harder, and the leverage exerted by an ankle weight would tend to keep my body in an upright position rather than simply providing balance to ease changing from one position to another.

I should point out that most of these problems only occur at the surface and once I get down to about 30 feet movement becomes a lot easier. Also I expect that as my ability and experience increase I may be able to do away with the thigh weights. If it seems necessary to use them on a permanent basis, I will have pockets sewn in the front of my suit above my knees. Velcro straps do have a tendency to slip. But first there is something else I want to try. Regular exercise, particularly to loosen and strengthen my lower back and stomach muscles. Right now I could do five sit-ups if someone put a gun at my head. I really cannot predict how much I will gain, but it is well worth a try. Also swimming laps in a pool will help with endurance. My goal is to become much more than a novice diver with a disability.

That about covers all the major problems I faced in regard to diving, but there are a few others perhaps I could touch on. It would not have been practical for me to have gone through a four to six week course offered by a scuba shop because it takes time and experimenting to go through the learning process of how to solve these problems, a process I am still going through. A crash course in a local shop may not allow time for this. Special problems in one individual in a class may become a frustrating burden to the instructor. That is what makes the Handicapped Scuba Association unique. It is designed not only to teach scuba but to tackle those problems as a challenge, not a burden. I have not forgotten those extra hours that some capable people were willing to spend with me to help me work out answers to my problems. I have been fortunate to dive with buddies who understand my limitations, which allows me to feel comfortable in the water with them.

For me diving is an exciting adventure. A really important part of what makes it enjoyable is the continued association with HSA members. What makes the HSA such an unusual organisation is that it provides a means for overcoming disabilities. It is not merely a club for the handicapped, it exists for the able-bodied who want to learn scuba. It is good to belong to a club that concentrates on PEOPLE rather than on their disabilities.

This remarkable testimony to the importance of the human spirit in discussing Fitness to Dive has been slightly edited from its original format as a letter. Readers may like to know that the HSA is a Californian Non-profit Charitable Foundation and that all its officers have a physical disability of one sort or another. The aspiration is to teach and promote diving for the handicapped, as well as additional aquatic sports such as sailing and fishing. It is based in California but has chapters in Florida and Ohio and correspondence with groups in Michigan, Canada and the UK. Its basic philosophy is to concentrate on ABILITIES not the disabilities, gladly accepting a great deal of input from pupils. This creates a situation where the instructor frequently finds himself in the role of student. It has accepted amputees, paraplegics, quadriplegics and cerebral palsy sufferers. Its classes are unique in that there is a mix of handicapped and able-bodied. This creates a sensitive learning experience for both, as some tasks can be done better by the disabled persons. On completion of training there is entry into the Scuba Diving Club, which runs dive trips for members and others. This is organised by the HSA Vice-president, Larry Thompson. Larry is a partial paraplegic who has nearly completed his NAUI Assistant instructor course. The address of HSA is:-

Jim Gatacre,
Programme Director
Handicapped Scuba Association,
1104 E1 Prado,
San Clemente,
CALIFORNIA 92672
USA

THE DIVING CANDIDATE WITH A HISTORY OF ASTHMA

CG Daugherty

The history of asthma is considered disqualifying for diving, even if not currently active or inactive for a considerable period of time. It is disqualifying by the US Navy, the North Sea regulations of the United Kingdom and Norway, and this also represents the opinion of the majority of physicians in the United States who are knowledgeable in diving medicine. The following factors should be considered, particularly if the diagnosis may be somewhat in doubt:

Safety in the Workplace

There is a general requirement for an employer to maintain a safe, healthy workplace. The employer cannot knowingly hire someone who is physically or medically unsuitable for the proposed job. The employer has a legal requirement to have prospective employees examined in a fashion sufficient to exclude persons having conditions which would render them unsuitable for the job in question. Thus, a history of asthma would make one unsuitable for the occupation of commercial diver.

Provocation of Asthma

Asthma may be defined as a condition in which the airways of the lung narrow and become smaller in response to stimulation which has no effect on ordinary people. Although the person may not have had an attack of asthma in many years, the potential still exists. As this reaction may be caused by situations which do not usually affect ordinary people, this means an attack could be triggered under what are considered to be normal working conditions. This is certainly true of diving, where divers are required to breathe dry gas mixtures for prolonged periods of time. This will typically cause tightness in the chest, coughing, and mild chest discomfort of a temporary nature. This is exactly the sort of exposure that could quite possibly provoke an attack of asthma in a susceptible person.

Diagnosis of Asthma

There may be some question as to how definite the history of asthma is. In infancy and early childhood, there are common virus infections of the chest which can produce wheezing and are sometimes mislabled as “asthma”. In some cases there may not have been a formal medical diagnosis of asthma. Rather the person may simply have been told by his parent that he had asthma early in his life. This may have been based on an episode of wheezing which appeared to represent asthma to the parents, or perhaps to the person’s own physician. The question can sometimes be difficult, particularly in young children. A few appropriate questions to one’s parents or family physician may help clear up the matter. Generally, asthma does not consist of a few illnesses with wheezing early in life, but rather consists of repeated episodes of wheezing throughout childhood or even into adolescence and young adulthood. Where there is a definite, unmistakable history of asthma earlier in life, the question should be considered settled at that point. There is no benefit for someone with a clear-cut history of asthma to consider the idea of attempting to enter the field of commercial diving. An attack of asthma while diving, under hyperbaric conditions, could prove fatal to the diver.

Testing for Latent Asthma

There may be cases where genuine doubt exists as to the correctness of an earlier diagnosis of asthma. For those willing to go to the trouble, there are further tests which can be done and are reasonably specific to this subject. It should be emphasized at this point that anyone who has a history of asthma, even if it is only a suspicion, now bears the burden of proving that he does not have asthma. In the absence of accurate information to the contrary, a history of asthma alone is sufficient to disqualify from diving. First, the person should have a standard pulmonary function test (spirometry) performed. The results of this test should clearly be within the expected range. Following this, the test should be repeated after the person has received a bronchodilator. Comparing the results of the two tests, there should be no significant change on the pulmonary function study obtained after receiving the bronchodilator. While there is a tendency for a person to show slight improvement on repeated tests due to the effect of practice, definite improvement on the second test may be taken as circumstantial evidence that the patient is an asthmatic or has some asthma-like narrowing of the airways in the lung. If this first before-and-after test shows no suggestion of asthma, a second test should be done. This involves the inhalation of methacholine or histamine. These compounds will cause no reaction in ordinary people when given in extremely small dosage. In asthmatics, a definite reaction is usually provoked and a positive result on this test is usually taken as an indication of latent asthma. Both of these tests can be done in any well-equipped pulmonary laboratory. It should be emphasized that, in the case of the second test, the compound must be administered by very finely-calibrated equipment. In addition, the reaction produced can be rather severe and therefore the test should not be done in any laboratory that is not properly equipped. If both of these tests produce no sign that the patient has asthma, it could reasonably be concluded that the earlier history of asthma was probably in error and a future in diving could be contemplated.

While it is certainly true that a person with an incorrect diagnosis of asthma can participate in diving with perfect safety, a person who does have asthma could very possibly have an accident which would result in permanent disability or death. It should be obvious that rigorous, thorough testing in order to resolve the question is of considerable importance.

WHEEZY DIVER

John Betts

Probably the most common problem in my postbag of reference cases is the young asthmatic. No other condition needs such a delicate balance of judgement by the examining doctor or exemplifies so much the differing philosophy of amateur and professional diving.

Asthma is caused by contraction of the smaller bronchioles in the chest, which close down and restrict the flow of air to and from the alveoli, thus causing the characteristic “wheezing” and producing shortness of breath.

In young people it can result from allergies to dust or pollen, from emotion, (particularly if unpleasant), infection or exertion and in many cases from no apparent cause.

The danger while diving is two-fold. Minor crises are inevitable in even the best ordered diving and a panicking asthmatic who develops an attack when difficulties arise may turn a problem into a major crisis.

Secondly the narrowed bronchi will restrict the easy expansion of compressed air in the chest while surfacing from a dive, thus producing lung rupture and cerebral air embolism, particularly if an emergency ascent has to be made.

So we do not accept anyone who has any permanent degree of asthma and, because the drugs used in treatment also affect heart and circulation, anyone who has to take any pills regularly for his asthma. Ideally, the diving asthmatic should have infrequent attacks and not take any regular treatment.

In recent years, however, two new treatments have appeared. One, Intal (sodium cromoglycolate) is a British discovery, an inhaled powder which stops the irritant reacting with the bronchioles.

The other is also inhaled and is a mist of particles of steroids, a drug which switches off the body’s reaction to allergens and when used in this way is not absorbed into the body. The same drug has been used for many years by mouth for asthma but has so many other effects on the body that it rules out diving.

The use of these types of inhalation may produce a completely normal chest while they are taken regularly, thus allowing sufferers to dive with safety.

It is in this area that the differing requirements of amateur and professional diving become evident.

The professionals, needing a man who will be available to dive come hell or high water, ban all asthmatics from diving, while as amateurs we accept someone who may have to opt out of a weekend's diving.

Our more lenient policy has proved itself over the years by the absence of any recorded serious incidents involving asthmatics.

Reprinted, by kind permission of the Editor, from DIVER (April 1982).

THE EARLY DAYS
HOW MARVELLOUS WITH AIR!

Don Linklater

During World War II I was a Company Commander in the Torres Straits Light Infantry Battalion. My men had been pearl shell or trochus divers who made their goggles from carved "kapok tree" with insert of glass. Such goggles did not suit me, so I made my own from an army issue type mirror, the de-silvered glass being fixed into a piece of jeep tube split to form four straps which enclosed my head. A friend whom I had trained to dive used such a mask while diving to remove a net fouling the propeller of a ship taking part in the Labuan offensive. I later copied this mask and produced it commercially in Australia.

My men gave me advice based on their diving experience: *"Now you listen true, Captain. If you in front of a deep reef and put your hand in a cave and that hand taken by conger eel, be calm, put your trust in God. Put you head on your arm and pray for the eel to change his bite. When he moves his mouth, punch your hand deep into him then pull one time with both legs and arms, or you will die!" "If you are swimming and tide coming and miss your boat and friends, look quickly at the highest coral rock on the reef, tie all the strings you can take and make enough to tie to the rock so you can breathe when the sea is deep and hold on."* I knew of Torres Strait Islanders who spent the night on coral niggerheads, rising and treading water to breathe, keeping their position till dawn and the return of the rescue boat from the lugger, simply saying to their rescuers, "I knew you would come back!" They knew the importance of avoiding panic. On one occasion in Fiji I was in a similar situation. The spill of water over the reef as the tide fell was so powerful that I had to dive and hook my speargun spear into the coral, rising on the cord to breathe from time to time and then progressively changing the anchorage of the spear until reaching the safety of shallow water.

During the war I obtained some Japanese diving equipment from an old pearl-shell warehouse, made up the airlines and put together an old air pump of the manual type. The army would not let me have a sensible boat so I had to make do with an old barge. My tenders were ex-divers but could not cope with the change of tide or the violence of the water, the worn-out pump bearings which overheated and seized up and the fact that the pump was not tied down firmly owing to a lack of anchorage points. Once when I was in the Helmet at about 100 feet, the pump slipped and slid, changing the barge's balance. Although the men did everything they could, the pump slipped suddenly across the barge and into the water, and down to join me. They dragged me to the surface by the lifeline, lifting me bodily by the neck like a fish into the barge, bleeding from ears, nose and mouth. I was ticked off by my Battalion Commander for trying to get pearl shell for the nurses at Thursday Island and reminded that I was to kill Japanese, not myself.

During my days in the swamps of New Guinea my men swimming with me in the swamps suddenly left the water. They explained that they had seen a black cod among the roots in the shallow water. I asked why they were worried and they said that because the water was shallow and we were looking into the dark, this cod was known to suddenly rush and bite off the lips of spear-fishermen.

After the war I purchased some oxygen equipment from a member of the Navy. The unit contained damp, old, deteriorated soda-lime and he suggested that I regenerate it by putting it out on the rocks on a hot day. When I used it for a deep dive off Sydney I felt very, very queer. Because of the fatalities the Navy later restricted the use of oxygen sets to no deeper than 25 feet and introduced the use of oxygen-nitrogen mixtures. So we dived with compressed air equipment made up from Air Force oxygen bottles and a modified copy of Cousteau's demand valve, and felt more confidence when at depth.

One chap had a small air compressor under his car to be driven by the moving parts. He drove 30-miles with the compressor gathering in the worst atmosphere possible plus the "cracked" lubricating oil used in the cylinder. He was found dead within minutes of diving. I can still remember some of my doubts about early compressed air. I can taste the weird burned oil. I can see the air bubbles breaking on the surface and literally giving off blue smoke!

Among the most dangerous of the early "aids" was a floating mini-boat carrying an extended snorkel, connected to the diver by a long rubber tube. Nothing dangerous happened if the valve system worked and the user was near the surface, but users often passed out because they attempted to draw air down at depth or because the valve was faulty and they were rebreathing their exhaled air, the inhalation tube being too long for flushing if used during exhalation. Near deaths, but no actual fatalities, were reported to occur.

The early snorkels were definitely dangerous and some fatalities are believed to have resulted from carbon dioxide build-up through failure to adequately clear long/wide tubes, children being particularly at risk in this respect. There were also various ping-pong ball valves suggested. Gradually the clever snorkels gave way to simple short pipes which demanded a complete "spume" to clear, and users found they were clearer headed.

One of the strangest pieces of apparatus was a type of hookah unit, a lever operated double piston pump mounted on a small raft. It required the services of a person to do the pumping and could only achieve shallow depth but many were sold before it was superseded by better apparatus.

The early diving suits were merely a wrap-around of rubber (seal skins) which compressed the woollen garments and minimised exchange of water. Some dry suits were used with the SALVUS rebreather sets, but when the water compressed the material onto the body it was almost inflexible and wooden. The introduction of neoprene foam was the factor which led to the introduction of wet suits.

When I was diving we played with hyperventilation and during a long dive there seemed to be a mental barrier, after which there was another stage. In this dangerous phase there would be a lot of coloured lights, palpitations, flushed face, etc. During an international spearfishing competition in 1965 Wal Gibbons lost consciousness during ascent from a 100 foot dive and was rescued by Bruno Hermany, the Brazilian champion, 30 feet from the surface. He made a successful recovery, though hospitalised and prevented from competing further in that competition. Years ago as I stood on the diving step of a swimming pool in Surfers Paradise some young blades on an outing gave me a slow clap and hollow cheer. The water was dirty but I dived in and on impulse went into my underwater Yoga, slow movement, passing through the mental block. I went the length of the pool four times, and as I had been resting on the holiday and was completely relaxed I think I managed three minutes plus underwater. When I surfaced the manageress was hysterical, the busload of people were looking into the water, some taking off coats and there was a general air of *"What do we do now?"* I do not dive like that any more, but am aware of the mental release to be triggered by hyperventilation diving, though aware also of the great dangers involved.

Some people are lucky enough to have quickly equalising middle ears but I have been troubled all my life. I tried to get specialists to burn the Eustachian passage clear but was told that would produce damage and was advised to take up sex or stamp collecting instead of deep diving.

With my wife Lois, I have dived through syphons connecting underground river caves at Jenolan. Although we had trained carefully we were caught by the unexpected, the rising of very fine silt changing the incredible visibility to a blackout. It was a case of stop and pray before doing anything, watching the moving silt across the underwater headlamps to get the direction, slowly following the guide rope where it had been pulled into knife thin cracks. One chap broke discipline and unclipped his line and tore directly through the team. He lived but the panic could have killed him and others.

Panic is a major danger in diving. I remember being at depth in Lord Howe Island Lagoon, caught in a cave with spearline draped around me, fish and coral antlers.

Edward du Cros arrived behind a propelled torpedo, undid the cord (and saved my life) gave an Englishman's controlled nod of the head, and swam off towards the depths. Another time at Lord Howe I and my buddy were in trouble when a current washed us away from the shore. I reassured my companion and we allowed the current to take us out to sea and then bring us back near enough for a swim back to shore. Panic would have been fatal in either of these incidents.

Eric Jolliffe, the black and white artist of Narrabeen, summed it all up a quarter of a century or more ago, when we took him diving with aqualungs - *"Gee, that was marvellous"* he said. We nodded. *"I imagine what it must be like when you have got some air to breathe."*

We had given him an empty bottle!

Department of Energy,
Petroleum Engineering Division,
Thames House South,
Millbank, London, SW1P 4QJ

25th May 1982

DIVING SAFETY MEMORANDUM NO 14/1982
DIVING BREATHING GASES/PURE HELIUM

Diving legislation requires the diving contractor to provide a supply of breathing mixture suitable in content and of adequate pressure and at an adequate rate.

Diving Safety Memorandum No 11/1981 aimed at drawing the attention of all diving companies to the importance of always supplying a safe breathing gas. The Memoranda expressed the need to ensure that all breathing gas storage cylinders are correctly marked as to their content. It went on to recommend that all gas supplies should be tested before being put on the line and that all supplies to diving bell and divers be continuously monitored for oxygen content and be fitted with a visual/audio oxygen high/low alarm.

Prior to the issue of the Diving Inspectorate Safety Memo, the Diving Medical Advisory Committee to the Association of Offshore Diving Contractors issued a recommendation which states "the Committee endorses the recommendation that a mixture should be used in place of helium offshore, although it is felt that the contractors may need to use pure helium as a calibration gas. The choice of mixture should be left to the diving contractor but a minimum of perhaps 2% of oxygen would present no problems operationally from 50-150 metres, and from 150 metres to greater depths in the North Sea, a smaller percentage may be appropriate".

There is no doubt that the supply of pure helium to a diver can be lethal and resuscitation from the resultant hypoxia almost impossible whereas "animal experiments" indicate that even a small percentage of oxygen can prevent death.

It is not the intention of the Diving Inspectorate to recommend any change in legislation as the diving contractor is already required to provide plant and equipment necessary for the safe conduct of diving operations and that plant and equipment shall include a means of supplying a breathing mixture suitable in content and temperature and of adequate pressure and at an adequate rate to sustain prolonged vigorous exertion at the ambient pressure for the duration of the diving operation. However, diving contractors should take note of the DMAC recommendation.

DIVING SAFETY MEMORANDUM NO 15/1982 SURFACE DECOMPRESSION TECHNIQUES AND DECOMPRESSION SICKNESS 13 AUGUST 1982

Recent years have seen an increase in the use of surface decompression techniques and, in general, the decompression sickness incident rate is low. However, over the period of the last year several type II bends and medical emergencies have arisen during or after air diving using surface decompression techniques which subsequently required "on site" qualified medical expertise and on shore medical back-up. The attention of all diving supervisors' is drawn to the importance of seeking early medical advice in such situations and by so doing may avoid a potentially dangerous therapeutic procedure being adopted and a long, uncomfortable stay in a facility that is not designed for such events.

Reference is also made to my Diving Safety Memorandum No 12 of 1979.

DIVING SAFETY MEMORANDUM NO 16/1982 AMENDMENT TO MEMO NO 9/82 23 AUGUST 1982

Please amend the last paragraph of Diving Safety Memo No 9/1982 to read:-
"the planned duration of a normal saturation exposure for any individual should not exceed 28 days and it is recommended that the minimum time between saturation dives should not be less than the period of the previous saturation dive."

DIVING SAFETY MEMORANDUM NO 17/1982 EXAMINATION AND TESTING OF LIFTING EQUIPMENT HEALTH AND SAFETY DIVING OPERATIONS AT WORK REGULATIONS 1981 24 AUGUST 1982

Diving Safety Memorandum No 5 of 1982 pointed out that Regulation 13(1)(c) and Regulation 13(2) requires the examination and testing of lifting equipment used in the launch and recovery system for diving operations to be carried out on initial installation, after any major repair or alterations to the plant or equipment and at six monthly intervals.

"Tested" is not defined in the legislation but the following should be considered as guidance to the competent authority carrying out such examinations and tests.

On the first installation and thereafter after repair or alteration, the test should be an "overload" test. Acceptable "standards" will include those published by classification societies and other relevant bodies having experience in this type of work and those contained in documents such as ship building regulations.

At other times, (every six months) and subject to acceptance by the competent person, a functional or operational test to maximum normal working load will satisfy the regulations.

"Standards" vary in detail but in all cases the maximum normal working load of, for example, a diving bell is the total weight of the bell in air at water level (ie. including maximum cable weight) when operationally manned.

Legislation places considerable importance on the role of the competent person and in particular circumstances he should use his judgement which should follow the philosophy of this guidance.

This memorandum cancels Diving Safety Memorandum No 5/1982.

DIVING SAFETY MEMORANDUM NO 19/1982 THE USE OF EPOXY RESINS BY DIVERS 11 NOVEMBER 1982

Epoxy resins, often with tar additives, are being used by divers for underwater repairs. Every precaution should be taken to avoid contaminating the diver or the chamber complex with uncured epoxy resins as these compounds can create a significant health hazard under hyperbaric conditions.

In a recent study carried out for Department of Energy's Diving Inspectorate typical uncured resins designed for use underwater were analysed. The analysis indicated that physical contact could lead to dermatitis and eye damage. Prolonged inhalation of fumes could lead to narcosis, irritation of the eyes, nose and throat and possibly asthma. This inhalation hazard becomes significant when about 50 grams of uncured resin is brought into a chamber complex of some $20m^3$ overall volume.

Gas analysers with sufficient sensitivities (naphthalene 0.6 mg^{-3}, methanol 3 mg^{-3}, benzene 0.4 mg m^{-3}) and scrubbers suitable for removing these contaminants are not generally available offshore, therefore prevention must provide the main protection against divers being exposed to the toxic effects of epoxy resins. This can be achieved by:

1. All tasks should be designed so as to avoid the diver coming into direct contact with the resin. All resin containers, pressure lines etc., should be remote from the bell and chamber system.

2. Divers using resin handling equipment should wear disposable coveralls which can be jettisoned outside the bell in the event of accidental contamination,

3. The diver and bellman should apply a suitable barrier cream to all areas of skin likely to come into contact with resin whilst working or whilst undressing a contamination diver.

4. A decontamination scheme should be devised to cater for accidental exposure. This entails providing protective clothing, disposal containers, non-toxic cleaning agents, decontamination schedules and inter-chamber gas flow schemes. All this being aimed at minimising the quantity of uncured resin which can be transferred to the living chamber.

5. The addition of a fluorescent dye to epoxy resins greatly aids detection and isolation of any contamination within a chamber.

6. Screening out divers who are already sensitised to epoxy resins would decrease the chances of dermatitis occurring during a saturation dive where these materials are involved.

DIVING SAFETY MEMORANDUM NO 20/1982 BREATHING EQUIPMENTS/VALIDATION 12 NOVEMBER 1982

Many new types of underwater apparatus are now coming into general use and in particular equipments designed for helium conservation.

Incident reports indicate that in some cases divers are not being properly briefed and trained in the use of this new equipment.

Divers should always be briefed and trained and validated in any new piece of equipment, drill or technique.

DIVING SAFETY MEMORANDUM NO 21/1982 DIVING FROM DYNAMICALLY POSITIONED VESSELS 19 NOVEMBER 1982

The operation of thrusters and propellers on dynamically positioned vessels can present hazards to divers. This particularly applies in surface oriented diving.

Divers' umbilical lengths should be physically restricted to a length which would not permit the diver, under any circumstance, to come into contact with any thruster or propeller. Should the diver be operating from a bell or basket the same drill must apply. Whilst recovering the bell or basket to the surface particular attention must be paid by the attendant to ensure that the umbilical from surface to bell or basket does not form a bight which in turn could become involved in thrusters or propellers.

DIVING SAFETY MEMORANDUM NO 22/1982 DIVING BELL THERMAL SURVIVAL KITS

31 December 1982

The provision of thermal survival kits in diving bells goes some way towards improving the divers' survival chances in a lost bell situation. However, it is not easy for divers in the restricted confines of a bell to set up and don the thermal protection. Practice in this technique is essential if the survival kits are to be used to maximum efficiency.

Diving contractors should ensure that all their bell divers are instructed and practised in the use of survival kits.

A new terminal objective will be included in the bell diver standard to cover this point.

COMMANDER SA WARNER
Chief Inspector of Diving

MEMBERSHIP OF SPUMS

Members pay $20.00 yearly and Associate Members $15.00. Associated Membership is available for those neither medically qualified nor engaged in hyperbaric or underwater related research. Membership entitles attendance at meetings and the Annual Scientific Conference and receipt of the Journal/Newsletter.

Anyone interested in joining SPUMS should write to:

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

COURSE IN HYPERBARIC MEDICINE FOR DOCTORS AND NURSES

Prince Henry Hospital, Sydney Friday March 2nd to Sunday March 4th 1984

Physiology, Medicine and Applications of Hyperbaric Medicine

Chamber work may be available for suitable candidates

Further information from
HBO Course,
Department of Anaesthesia
The Prince Henry Hospital
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MATRAVILLE NSW 2036