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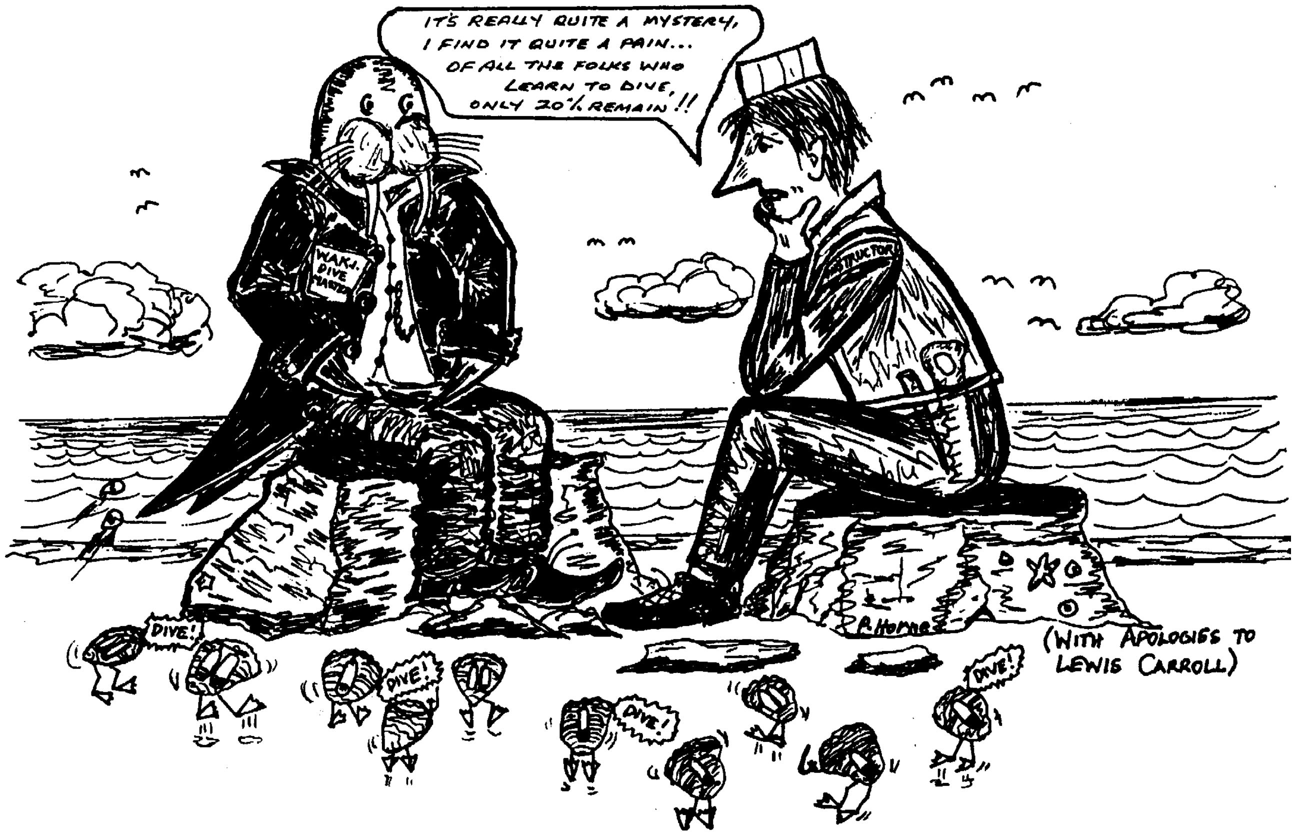

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OBJECTS OF THE SOCIETY

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

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

The subscription for Full Members is $A35.00 and for Associate Members is $A25.00. New Zealand members' subscriptions ($NZ 50.00 and $NZ 35.00 inclusive of GST) should be sent to Dr Andrew Veale, Secretary/Treasurer of the New Zealand Chapter of SPUMS,19 Otahuri Crescent, Greenlane, Auckland 5.

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

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Contributions should be typed in double spacing, with wide margins,on one side of the paper. Figures, graphs and photographs should be on separate sheets of paper, clearly marked with the appropriate figure numbers and captions. Figures and graphs should be in a form suitable for direct photographic reproduction. Photographs should be glossy black and white prints at least 150mm by 200 mm. The author's name and address should accompany any contribution even if it is not for publication.

The preferred format for contributions is the Vancouver style (*Br Med J* 1982; **284**: 1766-70 [12th June]). In this Uniform Requirements for Manuscripts Submitted to Biomedical Journals references appear in the text as superscript numbers. [1-2] The references are numbered in order of quoting. The format of references at the end of the paper is that used by *The Lancet,* the *British Medical Journal* and *The Medical Journal of Australia.* Examples of the format for journals and books are given below.

1 Anderson T, RAN medical officers' training in underwater medicine. *SPUMS J* 1985; 15: (2) 19-22
2 Lippmann J,Bugg S. The diving emergency handbook. Melbourne: J.L.Publications, 1985

Abbreviations do not mean the same to all readers. To avoid confusion they should only be used after they have appeared in brackets after the complete expression, e.g. decompression sickness (DCS) can thereafter be referred to as DCS.

Measurements should be in SI units. Non-SI measurements can follow in brackets if desired.

THE MARINE STINGER HOTLINE

TOLL FREE NUMBER 008-079-909

The Marine Stinger Hotline is now toll free Australia wide. The old number was only available in Queensland. Arrangements have been made with Telecom to place a recorded message on the old number dto direct callers to the new number.

For advice about the treatment of marine stinger injuries dial **008-079-909**.

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This contains further papers presented at the ANZICS-SPUMS Meeting in Rockhampton in October 1983.

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This contains papers from the 1986 and 1987 Annual Scientific Meetings and papers assessing dive decompression computers.

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SOUTH PACIFIC UNDERWATER MEDICINE SOCIETY ANNUAL SCIENTIFIC MEETING 1989

This meeting is scheduled to finish so that members can have adequate time to travel to the

UNDERSEA AND HYPERBARIC MEDICAL SOCIETY MEETING

in HAWAII from June 7th to 11th 1989
and enjoy and contribute to this meeting

For further information about the
UNDERSEA AND HYPERBARIC MEDICAL SOCIETY MEETING
write to
Dr Leon Greenbaum Jr.,Ph.D., Executive Director of UHMS,
9650 Rockville Pike, Bethesda,
Maryland 20814,
U.S.A.

STOP PRESS

UNIVERSITY OF NEW ENGLAND
Department of Continuing Education
will be holding a
MEDICAL UPDATE CONFERENCE
on
SPORT DIVING
on October 14th, 15th and 16th 1988
in ARMIDALE NSW

The conference objectives are to;

Inform medical practitioners and other persons involved in the care and tratement of sports divers, of the techniques for performing medical examinations on prospective scuba divers.

Inform medical practitioners and first aid personnel about emergency treatment in sports diver accidents.

Improve sports divers' awareness of physiological and medical aspects of diving.

Provide update material for practising diving instructors.

Speakers include Dr Chris Acott,Dr Carl Edmonds, Dr Rod Green (RAN School of Underwater Medicine), Professor Brian Hills and Mr John Mathieson. Ms Carol Wright will be the introductory speaker.

Registration fees
Residential $190.00, Non-residential $148.00. Registrations close on 29.9.88.

For further details contact

Mr Carl Petersen,
Conference Co-ordinator,
Department of Continuing Education,
University of New England,
PO Box 591,
TAMWORTH, NSW 2340.
Phone (067) 66 3860 (work) (067) 66 5552 (after hours

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Advertising space is available in the SPUMS Journal. Rates on application from the Deputy Editor whose address apppears inside the front cover. Deadlines are January 31st, April 30th,July 31st and October 31st.

EDITORIAL

The paper by Robert Monaghan brings into the open a fact which has long been known to the industry which services recreational diving but which is rarely, if ever faced, the extremely high wastage rate that rapidly thins the ranks of newly trained divers. While it is probably a good thing that everyone trained does not continue to dive regularly, as otherwise the near shore waters would be too cluttered by dive boats and divers to allow any other traffic, there are more important implications than the loss of potential sales of diving equipment, which is perhaps the primary concern of the dive shop owners. It has been frequently shown that it is the inexperienced who most commonly feature in fatal diving incidents. While this may be a fact which can be limited to some degree by an ongoing rewiew of the content of training courses, inevitably inexperiece will remain an adverse factor in diving as in all other spheres of human activity.

It was a mathematician, Charles Dodgson (alias Lewis Carroll) who put into words the fact that it can sometimes require one to run very hard to remain in the same place (White Queen to Alice). This thought must often strike members of the dive shop industry when they contemplate that in the US growth between 1974 and 1980 was the small amount of 2.5%. This makes a suggested 80% loss from scuba diving of newly trained divers seem wildly optimistic. Those who depend for their living on servicing recreational divers do not seem to have identified the reason for this state of affairs. The most likely cause is the selling of unrealisable dreams. The new divers may be expecting better run dive clubs with more interesting dive programmes (and the better clubs which exist are beneficial to the dive shops involved) or have realised that their skill is only a toool and not and end in itself. The commercial diving industry exists, and will continue to exist, while divers can perform tasks more cheaply and efficiently than can machines. The recreational diving industry depends on providing a dive purpose which can be presented as a challenge, and the time is now past when it is either politic or accurate to sell the idea of DANGER! and a macho image to potential divers. In fact scuba diving is being sold as something anyone can do, which perhaps stretches the truth somewhat.

Faced with the fact that a bland image may be a kiss of death to the business hopes of the dive shops, and actual fatalities are certainly bad for business, the only way forward may be to educate those involved in Marine Science so that they learn to think of utilising the pool of potential helpers which must exist in the scuba diving population. Indeed all the earliest diving clubs in Australia were reseach orientated. It should be recognised more widely that the amateur portion of the diving community has been a greater factor in the development of present day diving methods and of the drive to make diving safer than has been the commercial diving industry since its inception. It is relevant to remark here that the main recreational diving organisations in Australia and New Zealand have greater awareness of the importance of trying to record and utilise “incident reports” than has been shown up to this time by the commercial diving organisations around the world. Hopefully they too will soon come to realise the value of the DIVEDATA DATABANK proposed and at present being operated by Project Stickybeak. One sign of the dawn of greater involvement in this project by the scuba diving industry in Australia is the recent presentation to your Editor of the Australalian Scuba Council Award. He hopes this is indeed an indicator of progress in the task of persuading divers to send in reports. But he is not holding his breath while he waits for the postman !

We live in an age when people are more likely to demand not a mere pound of flesh but mega kilos of cash and it is for this reason in particular that our Society is becoming incorporated. Once we have a notional body our physical, and financial, bodies can rest more secure. The plea of having spoken the truth, the whole truth and nothing but the truth is no more protection nowadays in a court of law than was to be in the right when faced with a Trial by Combat where the other party had a stronger, or more skilled, champion fighting on his behalf. But such is life, as a certain well know historical character once said on accepting that he was on the wrong end of a fatal legal decision.

We urge all our readers, especially those who intend to attend the Annual Scientific Meeting (ASM) in Port Vila, to travel to Honolulu to attend the Undersea and Hyperbaric Medical Society (UHMS) meeting in Hawaii. The scientific meetings of UHMS are well worth attending.and the SPUMS ASM has been scheduled to allow plenty of time for the journey to Hawaii.

Finally we tender our apologies for the late appearance of this issue, and warn our readers that the next issue will probably also be late.

PROVISIONAL REPORT ON AUSTRALIAN DIVING-RELATED FATALITIES 1986

Douglas Walker

Fourteen (14) diving-related fatalities were identified as having occurred in Australian waters during 1986. Two (2) were breath-hold divers, nine (9) were using scuba, and three (3) were using surface supply (hookah) systems. One of the breath-hold (snorkel) deaths occurred from acute illness while the victim was on a day trip to the Barrier Reef and illustrates that there is an inescapable risk of the occasional "loss" of a person on such trips because complete supervision of a crowd of swimmers is difficult in theory and probably impossible in practice. While there is no clear common reason for the scuba diver incidents the one clear fact is the frequency with which the critical action of the incident occurred at the surface. Many of the victims had only slight diving experience although some were both trained and reportedly experienced. The hookah incidents indicate some of the dangers associated with the use of this equipment.

CASE SUMMARIES

BH 86/1

While on holiday at a resort near to the Barrier Reef the victim decided that he would like to try some snorkeling so attended a talk given by one of the resort staff on how to use a snorkel. He was described as being "not a good swimmer" but he apparently decided he would try snorkeling off a beach where the water was calm, warm, and shallow. Nobody particularly noticed him enter the water and his absence was only appreciated when his failure to return to his room to prepare for the mid-day meal led his wife to become alarmed. This was several hours later. She went to the beach to look for him and saw him floating quietly. He was face up and about 30 metres from the shore and the water was only waist deep where she found him. Her alarmed call for help quickly brought others to her and the victim was brought ashore. Although resuscitation was attempted there was no response. The snorkel he had used was described as being "soft". It is believed that this drowning occurred because the favourable factors of a calm, shallow, warm sea were more than balanced by the adverse factors of a lack of swimming ability and confidence, coupled with an unfamiliarity with mouth breathing through a snorkel tube with face immersed. It may be that he got some water down the snorkel and became so flurried by the unfamiliar situation that panic ensued and he forgot there was the simple remedy of standing up. Once panic strikes there is little hope of recovery if the victim is alone.

TOTAL INEXPERIENCE WITH SNORKEL. CALM SHALLOW WATER. POOR SWIMMER. SOLO. NO WITNESSES. DELAY BEFORE ABSENCE NOTED.

BH 86/2

This man was with a group of overseas tourists taking one of the many available day trips to visit the Barrier Reef. There is a report that he had a limp but this is all the information it has been possible to obtain concerning his health. The boat first visited a cay and after the passengers had viewed the birds there they were allowed some time for snorkeling before the boat sailed to its main destination, a reef. He was seen to snorkel at the cay in a competent manner. There was a party of scuba divers on board who went off together leaving the remaining passengers using snorkels close to the anchored boat. One of the crew now acted as guide or shepherd to this group and showed them the beauty of the reef beneath them. The sea was calm and water depth only 2 metres so after the guided tour was complete the "snorkel master" had no worries about safety when telling them they had half an hour to examine the reef near the boat before the return trip. But before he could get back on the boat he heard two of the swimmers call out that they had seen a body lying on the sea bed.

The crew member at once swam to them and dived to rescue the victim. He was soon joined by the leader of the scuba divers' group who had just returned from their dive. Resuscitation was at once started and was continued after the victim had been got back on board. It was continued despite the presence of an offensive watery regurgitation, or vomit, into the victim's mouth, a serious discouragement to continuation of EAR. The reason for the tragedy was revealed at the autopsy as shock following a haemorrhage from an acute pre-pyloric ulcer, a medical emergency with so rapid an onset he had no time to call to anyone for help. However close the supervision of a group is, it is not possible to monitor every person continuously.

ACUTE FATAL GASTRIC ULCER HAEMORRHAGE. SURFACE SWIMMING. NO WARNING CALM WARM WATER. NEARBY SWIMMERS UNAWARE OF TROUBLE. RESUSCITATION PROBLEM FROM GASTRIC CONTENTS REGURGITATION. MEDICAL HISTORY NOT STATED

SC 86/1

Although he was trained he had only dived intermittently. As he did not own a scuba tank he had to hire one whenever he wished to go diving. His health was reportedly good. This day the sea was calm so he decided he would go for a scuba dive and hired a scuba tank and asked a non-diver friend of his to accompany him when he went to the beach. It is assumed that he intended to hunt for abalone as he was seen to be carrying an abalone iron when he entered the water off some rocks. As soon as he had submerged his friend left the scene and went for a walk, returning to the car they had used to reach the beach. There he fell asleep. When he awoke he became alarmed when he realised how much time had passed without his friend returning. So he walked along the beach, in the hope of seeing him. Once he saw something in the sea and asked a windsurfer to check. But it was not his friend. So he decided to inform the police that there was a missing scuba diver. They mounted a full search. Bubbles were identified by the helicopter searchers and two police divers were directed to the area. They found the bubbles were due to the slow escape of air from the victim's regulator, which was floating above his head as he lay on the sea bed with all his equipment in its correct place. The autopsy appeared to provide no clues as to the cause of this incident but the histology report indicated the possibility that he was suffering from Toxoplasmodic myocarditis, a diagnostic possibility which was apparently never reported to the coroner. This could explain why he might have suddenly suffered a loss of consciousness. He died despite the sea being calm because he failed to ditch his weights, had no buoyancy vest, and was alone. His chances of survival would have been much better in the absence of such adverse factors. It cannot be known whether he attempted to call for help when he first began to feel ill. Nor is it known how long was the time from onset till death.

SOLO. CALM SEA. SUDDEN ILLNESS. PROBABLE TOXOPLASMODIA MYOCARDITIS. NO BUOYANCY VEST. FAILED TO DITCH WEIGHT BELT. NO WITNESSES.

SC 86/2

This case illustrates how easily a dangerous situation is able to develop even when those present respond to some seemingly minor misadventure in a rapid and reasonable manner. As this case has been reviewed at length previously (*SPUMS J*, 16, 1986.4.153-4), it will be summarised here. There were seven divers in the group, the victim and one other being newly certificated. The chosen dive platform was a rock ledge over which water occasionally came. The most experienced diver checked the water near the entry point before indicating to the others they should prepare to make their water entries. As the victim and another diver were standing near the edge of the rock shelf another of the group shouted a warning that a larger wave was coming and although it was noticed as only a mild swell by the divers who were in the water it knocked the two divers over as it washed over the shelf and poured into a channel on the other side. They were helped up but again tumbled over and the victim, much handicapped by the tank on his back, ended in this channel. As water was continuining to pour off the rocks and back to sea via this channel it seemed to the nearest member of the group to be a safer, easier, and quicker way to assist the victim resolve his problems if he used this route to reach open water than by an attempt to climb back onto the rock ledge and risk being knocked over again. But for the unfortunate outcome of the dive the decision might well have been applauded as being an eminently sensible response to a wild-water situation because it offered an opportunity for the diver involved to recover from his experience before encountering any further problems.

The victim was calmed by the presence of a diver who kept in close contact with him and he managed to partially inflate his buoyancy vest and started using his regulator. While he was being helped to reach open water he was noticed to show some panic, then he ceased using his regulator and became unconscious. He rejected his regulator, spitting it out each time it was replaced. Both the divers were now close to the other divers of the group. Also they were close to the rock lefge they had chosen to be both entry and exit point when planning the dive. It was agreed that it was more practical to get him speedily out of the water and onto the rocks than to make an attempt at in-water resuscitation and delay his removal to dry land. This was done. At the subsequent inquest it was suggested that the correct action would have been to start in-water EAR. However the likelihood of such a course of action leading to a successful resuscitation is highly debtable. Another matter on which the divers were criticised was their failure to be aware of the fact that although the sea appeared to be calm there were, every 30 or 40 minutes, sets of several large waves. It was stated by a Counsel that they should have known about these waves. As the dive leader had observed the proposed dive site for nearly 40 minutes before declaring the location safe he was possibly rather more careful than others. Had the water entry been commenced some few minutes earlier or later this tragedy would not have happened as the divers would have either been in the water, and hardly felt the surge or they would have seen it coming before they collected on the ledge in preparation for entering the water.

This incident illustrates how rapidly a change in the sea conditions can occur and transform some apparently completely safe situation into one of high risk. This inquest also illustrated the danger which faces anyone who has responsibility for a dive should there occur any serious misadventure. The danger arises not solely from any errors they may have made but also from the methods which are likely to be used by Counsel for some aggrieved party who will be quick to quote texts, such as the training manual of an instructor organisation, which suggest a different problem management.

It may be opportune to consider the validity of any proposition that the words in a Diving Manual have Divine Inspiration as their basis.

NEWLY TRAINED. GROUP DIVE. UNEXPECTED WAVES WASHED OFF FEET WHILE PREPARING WATER ENTRY FROM ROCK LEDGE. VALIANT BUDDY ASSISTANCE. DROWNED DESPITE INFLATED BUOYANCY VEST. RESUSCITATION DELAYED TILL BROUGHT OUT OF WATER. INVOLVEMENT OF COUNSEL IN INQUEST PREVENTED IMPARTIAL APPRISAL OF CRITICAL FACTORS.

SC 86/3

Although the victim was apparently trained, for this was a basic requirement before anyone was accepted by this club, she was certainly inexperienced and possessed none of the equipment which is necessary for diving. She hired the wet suit, mask and snorkel, borrowed a buoyancy vest, regulator and tank from the club, the fins came from one friend and her torch from another. The other divers also were largely dependent on the club equipment store when they prepared for this dive, the first night dive most of them had ever made. Despite the club rules one of the divers had apparently not yet completed her scuba training course. Another diver was making his first post-course dive. The objective was an offshore wreck, the dive platform a pier from the beach. It was a cold, rainy, dark night and the sea was choppy but they did not let this affect the proposed dive. There were five divers so they arranged to dive as a buddy pair and a group of three, which included the victim. The buddy pair started out first. The others were close behind at first but then lost contact. Then the "O" ring blew on the tank of one of the trio. The experienced diver in the trio turned his air off for him. As he obviously could not now scuba dive they decided he should return to shore and they would continue without him. It was agreed that it was safe for him to return alone as they still could clearly see the pier they had recently left. However only a short time later, while they were still snorkeling out towards the wreck, the victim indicated that she was finding difficulty taking a breath because of the tightness of her wet suit. Her buddy came to her assistance, orally inflating her vest, and she soon said she felt much better. They conferred and decided she should return to the shore, which she apparently now felt fit enough to do alone as her breathing had returned to normal, the wind was onshore, and her buoyancy vest was inflated. Her buddy advised her to start to use her scuba but it is possible that for at least part of her return swim she used her snorkel. The buddy now continued his journey to the wreck, there joining the original buddy pair. It was only when this dive was completed and the three divers returned to the pier that the victim's absence was noticed as naturally the person who had returned first had not known anyone was following him back to shore.

The body was washed ashore about 2 1/2 hours later, all of her equipment save for her mask and fins being correctly in place, but these were missing. Skin marks confirmed her complaint of the wet suit's tightness. Examination of the equipment showed that a much larger than normal effort was required to work her regulator. It lacked a neck strap (as did all the regulators in the club store). The fins had been too loose for her so she had worn socks. It was noted she had 10 kg on her weight belt, which was considered to be excessive for her. It is surmised that the combination of adverse factors, night dive, sea conditions, inexperience, the solo surface swim with inflated buoyancy vest, fatigue and anxiety, and then the loss of her fins and possibly letting the regulator fall from her mouth (as it had no restraining strap it would have been difficult to find again), all contributed to her drowning, which occurred despite an inflated "horse collar" buoyancy vest.

TRAINED. INEXPERIENCED. 2ND DIVE SINCE COURSE. NIGHT DIVE. COLD. WINDY, RAINY WEATHER. CHOPPY WATER. BORROWED AND HIRED EQUIPMENT. ONE BUDDY HAD RUPTURED "O" RING AND ALLOWED SOLO RETURN. VICTIM TROUBLED BY TIGHT WET SUIT. EXCESS WEIGHTS. BUDDY ALLOWED HER ALSO TO MAKE SOLO RETURN. FAILURE DIVE DISCIPLINE BY TRIO GROUP. DELAYED REALISATION THAT DIVER MISSING. FAILED TO DITCH WEIGHT BELT. DROWNED DESPITE AN INFLATED BUOYANCY VEST AND ADEQUATE AIR.

SC 86/4

So great was his determination to go scuba diving despite his obesity and poor sight (and other adverse medical facts which he failed to disclose, discussed in *SPUMS J* Vol 18 No 1 p 12-15) that he visited a number of dive shops and doctors in order to obtain permission to receive instruction. His final acceptance was a conditional permission to attend a course. His instructors early decided that he could never be permitted to obtain scuba certification and the limited acceptance was granted subject to him producing a medical certificate stating he was fit to dive. He obtained such a certificate after telling a doctor he was to join a special group of blind divers, a deliberately untrue statement. He also omitted to mention he had a history of asthma, though none of his diving problems arose from this risk factor, and his instructors never suspected him of having this condition while under their supervision. One of the several instructors he approached later stated that had he produced a fit to dive certificate he would have checked out the authenticity of such a document, then required a second opinion by a doctor with some knowledge of diving medicine, as he had grave doubts concerning the victim's fitness to scuba dive.

When he attended this class dive he had already been told he would not be certificated. He was only permitted to attend the lectures because he claimed this could not be prevented as he had previously paid for this course. Possibly the instructors were to some degree influenced by his extraordinary determination to make a scuba dive. They therefore permitted his attendance but had one of the assistant instructors assigned as his buddy. There were on this dive seven other student divers, all of whom had nearly ended their course, and the chief instructor was in charge of them. When the victim was descending he flooded his mask but seemed to have no difficulty in clearing it, which would have reassured his buddy concerning his skill level. After they reached the sea bed he had need once more to clear water from his mask and again managed the task in the correct manner. They then swam to a nearby rock shelf and it was now that he gave a signal that he wished to ascend and both started to ascend together. The buddy did not know why he wished to abort the dive but knew it was not due to a lack of air as they had checked the contents gauge readings as soon as they reached the sea bed and subsequently maintained hand holding contact. His buddy now noticed that his weight belt had slipped so tried to assist him get it back to its correct place only to find the task beyond their joint efforts, his corpulence defeating them.

The instructor came over and decided it would be best for him to retain his weight belt and for them to help him to ascend. He was instructed to keep his knees bent, to keep the belt resting on his legs (this also prevented him for assisting his ascent by finning). They inflated their buoyancy vests to assist the ascent and the victim successfully controlleo the venting of air from his own buoyancy vest. At the surface he was told he could straighten his legs to allow his weight belt to fall away but it tangled on his fins and had to be disentangled by his buddy. As there seemed to be no problem now remaining, the instructor now descended again in order to rejoin his patiently waiting seven pupils. The victim and buddy were close together with inflated buoyancy vests, plenty of scuba air, only about 100 feet from the dive boat, in a calm sea but as the victim appeared to be fatigued the buddy signalled for the boat to come and pick them up, then started to tow him towards the dive boat. After he had been helped aboard he suddenly became unconscious and only replied with groans to all questioning about what was wrong. Resuscitation efforts were immediately commenced, and though he was kept alive until they reached land he died soon afterwards. Although the autopsy report initially stated that the cause of death was drowning this diagnosis was amended when there was discussion with a RAN doctor versed in Diving Medicine and in consideration of the finding of widespread evidence of changes in the myocardium due to ischaemia the diagnosis was made that death was due to a “heart attack”, the consequent failure of his cardiac function causing the observed symptoms. There was evidence of his having suffered a “silent infarction” a few days previously.

WELL SUPERVISED, UNFIT PUPIL DIVER. OBESE. PART BLIND. FAILED REVEAL COMPLETE MEDICAL HISTORY. MEDICAL FITNESS ASSESSMENT IS DEBATABLE. SUDDEN ILL HEALTH UNDERWATER. UNABLE TO REPOSITION WEIGHT BELT SO ASSISTED ASCENT WEIGHTS ACROSS BENT LEGS. BELT SNAGGED ON FINS AT SURFACE. CONTROLLED INFLATION BUOYANCY VESTS HELPED ASCENT/SURFACE. VALIANT BUDDY ASSISTANCE. UNCONSCIOUS ON BOAT. HEART DISEASE DEATH.

SC 86/5

A tourist, one of a dive group which was accompanied by an instructor from her own country, died while scuba diving with some of her compatriates during a boat trip to the Barrier Reef. Though she was trained, as were all the members of the group, her exposure to diving was possibly under closely controlled conditions. She and her buddy made three dives without apparently experiencing any problems on the first day of the trip. On the second day, the boat had been moved to another location and it was anchored close to a reef where water depth was 20 metres at the boat, and shallower close to the reef, becoming deeper further out. The other passengers included six trained scuba divers, five under instruction who were with two instructors, and several divers with dive master status or trying to achieve this qualification. There was no lack of people well qualified to provide the resuscitation correctly when it unfortunately became necessary.

Two divers were noted at the surface seawards of the dive boat’s stern. They submerged without replying to signals from some dive masters who were standing there. A short time later one diver was seen to surface and as there was again no response to calls or signals they decided to send the safety boat to check that all was well. The correctness of this decision was confirmed shortly as the diver began to signal for assistance. Some of these watching divers dived into the water and swam quickly to help the diver in distress. It was only after a diver leaned out of the safety boat, an inflatable, to inflate this diver’s buoyancy vest that he saw first a fin, and then a body, floating a few feet below the surface. One of the divers attempted to inflate the victim’s vest underwater but was unsuccessful because her tank was empty of air but he nevertheless managed to raise her to the surface where she was grabbed and pulled into the inflatable. Her equipment was removed and resuscitation was commenced. This was maintained while on the dive boat and during the emergency helicopter flight back to land and to the hospital. She never regained consciousness and died in hospital six days later. Her symptoms were diagnosed as being due to cerebral anoxic damage due to the “near drowning” lung changes she had suffered. There was a possibility that she had suffered a cerebral arterial gas embolism (air embolism) so she was moved to a hospital near a recompression chamber. Unfortunately the extent of the lung and brain changes precluded survival and she died six days later.

Both of the divers were keen underwater photographers and were swimming back to the dive boat when they realised they might have come too far because the water had become deeper than the 20 metres depth which existed between the boat and the reef. Unknown to them a strong current ran off the reef. They therefore came to the surface to check their position, then descended again with the intention of continuing their return underwater. The victim began to experience some difficulty with her air supply before they had descended more than 3-4 metres so her buddy held her and assisted her to ascend. It is uncertain exactly what happened as the death did not occur for several days and the buddy returned home before there was any reason for the police to investigate this incident. As a consequence no deposition of evidence was obtained from her.

The autopsy revealed the changes expected for cases where death follows several days after immersion lung injury and anoxic damage to the brain. On the basis of the history of what happened it is reasonable to believe that she suffered a cerebral arterial gas embolism during her out-of-air ascent, lost consciousness, then inhaled water. Why she failed to ascend before running out of air cannot be known as she had a contents gauge. From 3-4 metres depth a reasonably experienced diver should have surfaced safely though cases of air embolism certainly occur where the victim has seemed to ascend in a correct manner.

TRAINED. SOME EXPERIENCE BUT POSSIBLY ONLY SHALLOW PROTECTED WATER. CONTENTS GAUGE BUT DESCENDED WITH NEAR EMPTY TANK. RAN OUT OF AIR BUOYANCY VEST INOPERATIVE AS TANK SUPPLIED. UNDERWATER CURRENT SO SWAM TOO FAR FROM DIVE BOAT. LOST CONSCIOUSNESS DURING ASCENT. RAPID RESPONSE FROM DIVE BOAT. RESUSCITATION BUT DIED LATER FROM EFFECTS CEREBRAL ANOXIA AND IMMERSION. CLINICALLY AIR EMBOLISM DEATH.

SC 86/6

While working at an island branch of his organisation the victim noticed an advertisement for boat dives and decided that he would like to join such a dive. He told the instructor who was in charge of the dives that he was trained but was without his card, it having been left on the mainland. The instructor hired him the necessary equipment and then checked how he managed it and how he managed himself swimming at the surface wearing full equipment, in this manner assuring himself that the victim really had knowledge of scuba diving. The dive location was a sheltered area which was nowhere deeper than 60 feet. This was because two of those making the trip had been diving earlier that day, another was newly trained and the victim was an unknown quantity to the instructor.

There were seven divers so they were assigned into a trio and two buddy pairs of divers, the instructor remaining aboard the boat as safety cover. The victim and his buddy had an uneventful dive lasting about 35 minutes at 45 feet depth. They maintained a good buddy discipline at all times, keeping contact during ascent, surfacing about 35 metres from the dive boat. They were observed to exchange “OK?” signs and inflate their buoyancy vests, and then to start swimming back to the boat in the calm sea. At some stage the victim changed over from scuba to snorkel and dropped back to the rear of his buddy who consequently reached the boat first and was hanging onto its stern when he heard a diver jump in and swim towards his lagging dive partner. He therefore swam back in order to see whether his help was needed.

The instructor had been watching their return so had seen the victim suddenly stop swimming and float quietly as if now too tired to continue. He therefor asked a diver who had boarded the boat after completing his dive to swim to him and ask if any help was needed. Unexpectedly he found that the victim was unconscious and floating face down so immediately turned him over, dropped his weight belt and commenced resuscitation (EAR) while waiting other divers to come to assist. Despite continued resuscitation efforts after getting him in the dive boat there was no response to their efforts. The autopsy showed that he had not drowned but failed to show a cause of death. Having regard to his recent ascent and the absence of any identified disease it was proposed that this death was presumed to be the delayed consequence of a cerebral arterial gas embolus. However this is diagnosis by exclusion rather than a positive finding.

TRAINING NOT STATED. EXPERIENCE NOT STATED. EQUIPMENT HIRED BUT SCUBA ABILITY WAS QUICKLY CHECKED BEFORE BOAT DIVE. BUDDY DISCIPLINE GOOD. CALM SEA. LOST CONSCIOUSNESS DURING SURFACE SWIM. INFLATED BUOYANCY VEST BUT FLOATED FACE DOWN. AIR EMBOLISM AS POSSIBLE CAUSE.

SC 86/7

There were seven divers taking part in this boat trip, one having failed to turn up in time. All were trained and the victim and his buddy were both experienced divers. Though there was some swell the condtions were safe for diving and never became unsafe despite a later increase in chop and swell. The two divers, victim and buddy, descended the anchor line to the sea bed, 27 metres, then moved to a shallower area for the next 20 minutes. They wished to avoid decompression problems and allowed time to reach the anchor line and ascend without requiring decompression stops. Because of their failure to locate the anchor they decided to make an ascent together in the open water, without the comfort and guidance which a line affords. The buddy at this time had 1500 psi remaining and the victim somewhat less but comfortably above the warning sector on his contents gauge. The buddy saw his companion start to leave the sea bed, then falter and sink down again and partially inflate his vest orally. As he was still unable to initiate an ascent the buddy put air into his own vest, took his hand, and by finning hard they managed together to leave the sea bed. They ascended face to face at an apparently normal rate without further problems so the buddy was surprised when the victim signalled for assistance from the dive boat as soon as they had surfaced. He assumed this to be from a dislike of making a 20-30 metres surface swim in what were now windy conditions and a surface chop.

Believing his companion would welcome some assistance, the buddy linked arms with him and started to tow him, both continuing to use their regulators. The victim seemed too breathless for the circumstances and was making frequent signals to summon help. Then he became limp. Fortunately at this time a line reached them from the boat and the man who had swam it across was able to take over from the buddy, who was very fatigued. He ditched the victim’s weight belt, which failed to drop away, caught by a strap belonging to the buoyancy vest. This was no problem as the vest provided all necessary buoyancy despite this. As soon as he had been pulled into the boat resuscitation efforts were commenced, first EAR, then CPR and oxygen, but he failed to respond. These resuscitation efforts were only interrupted to clear away froth and vomit. This is a problem that practice mannikins do not provide.

The autopsy showed marked lung changes were present which were interpreted as indicating an acute myocardial failure death, and the history of the incident could be interpreted as showing a developing cardiac failure. However there may also have been some element of pulmonary barotrauma, which would be likely to occur in a congested and therefore malfunctioning lung. It would seem that this fatality was, in the circumstances, quite unavoidable.

TRAIINED. SOME EXPERIENCE. OVER WEIGHTED ON SEA FLOOR SO ORAL PARTLY INFLATED BUOYANCY VEST. BUDDY CLOSELY ASSISTED AND ACCOMPANIED ASCENT. SURFACE EXCESS FATIGUE SO BUDDY ASSISTANCE. WEIGHT BELT ENTANGLED ON BUOYANCY VEST STRAP BUT GOOD SUPPORT BY BUOYANCY VEST. VALIANT BUDDY ASSISTANCE. CARDIAC DEATH.

SC 86/8

There is no information concerning the training or diving experience of this man but it is known that he owned a regulator which had an “octopus” second demand valve, had three scuba tanks, and was known to obtain air fills from several dive shops so must have made a fair number of dives. It is unknown whether he always dived solo or with others but this evening he was alone when last seen going back to the water after exchanging an empty tank for a full one he had left in his car. The fresh tank had only 26 cu ft capacity. He spoke to a bystander and it is therefore believed he was either intending to catch crayfish or spear fish, although the correctness of these suppositions is unknown. He failed to return home that night and the matter was reported the next morning. His health was described as being poor as he had weakness of his left side following a stroke, was obese, and became breathless even when walking on the level. An intensive search, from the air and by the police divers, failed to locate his body, which was washed ashore 7 days later still wearing the tank and weight belt. His scuba tank was empty and the LP hose intended for connection to his buoyancy vest (which was incorporated in his wet suit) was not connected.

The weights on his belt were rather forwardly placed such that though they did not impede closing the belt buckle they were preventing the easy operation of the quick release. It is thought likely that he ran out of air rapidly, having forgotten he was now wearing a small capacity cylinder, was naturally unable to inflate his buoyancy vest or ditch his weight belt, so drowned.

SOLO SCUBA. TRAINING NOT STATED. EXPERIENCE NOT STATED. SMALL CAPACITY CYLINDER. L.P. INFLATION HOSE NOT CONNECTED TO VEST. WEIGHTS OBSTRUCTED BELT QUICK RELEASE. OUT OF AIR. DELAY IN NOTIFICATION OF HIS ABSENCE. ILL HEALTH , OBESE, POST CVA (STROKE) WEAKNESS, EASILY BREATHLESS ON EXERTION

SC 86/9

Because he was older than either of his two companions it was agreed that he could leave them and return to the shore if he decided to abort the dive. Their plan was to snorkel out to rocks which were about 150 metres offshore, then to scuba dive. He was a trained diver with 2 years' experience, his companions having 1 and 6 years respectively. There was some swell but the water was calm inshore of these rocks, though it was rougher between them. On the outward swim they swam in line, the victim being in the rear. Both the other two divers swam through the rough water then waited for the victim to join them, which he failed to do. Being a little bit worried by this one of this pair allowed a wave to wash him up on a rock from which vantage point he was able to observe the victim floating quietly about 30 feet away and facing him. After he made an “OK?” signal he received a “Come and Help” signal so he removed his back pack, inflated its buoyancy vest, and gave it to his buddy before quickly swimming to the victim.

When the victim had made his signal requesting assistance he was holding his regulator in one hand as if intending to start using it. When reached he was floating face down, unconscious, with wavelets covering his face. The buddy turned him face up, put some more air in his buoyancy vest, ditched his weight belt, and made an attempt at in-water EAR despite the froth coming out of the mouth of the victim. Two nearby divers came to assist, responding to his calls for help, so he was able to continue his resucitation while they towed the victim towards the shore. No signs of any response were observed. The autopsy showed an apparently healthy heart and signs of drowning. The description of the incident however is not such as to support simple drowning as being the cause of death as cause was not identified. The sea was described as calm and while the buoyancy aid allowed an unconscious wearer to float in rather a dangerous face-forward position this would almost certainly not occur while the wearer was conscious. Possibly he suffered from a sudden cardiac arrhythmia but there is no evidence to support any such a suggestion except for his mode of dying. His regulator was said to require more than the correct effort to activate it, which would have increased the effort necessary to keep up with his two companions.

SURFACE SNORKEL SWIM WEARING SCUBA. SEPARATION. CALM WATER. BUOYANCY VEST PART INFLATED BY VICTIM. FLOATING FACE DOWN. WAVELETS OVER HIS FACE. QUIET RAPID DEATH AT SURFACE. IN-WATER EAR ATTEMPT CONTINUED WHILE TOWED BACK TO SHORE.

H 86/1

This was a day when everything seemed to go wrong,

TABLE 1

PROVISIONAL REPORT ON AUSTRALIAN DIVING-RELATED FATALITIES 1986

CASE	AGE	DIVE SKILL LEVEL VICTIM	BUDDY	DIVE GROUP	DIVE BASE	DIVE PURPOSE	WATER DEPTH	INCIDENCE DEPTH
BH 1	35	Not Trained Inexperienced	Not Applicable	Solo	Beach	Shellfish	4'	Surface
BH 2	35	Not Stated	Not Stated	Separation	Boat	Recreation	40'	Surface
SC 1	31	Trained Experienced	Not Applicable	Solo	Rocks	Recreation	10'	Not Stated
SC 2	34	Trained Inexperienced	Trained Experienced	Group	Rocks	Recreation	10'	Surface
SC 3	24	Trained Inexperienced	Trained Inexperienced	Group Separation	Jetty	Recreation	Not Stated	Surface
SC 4	40	Some Training Inexperienced	Trained Experienced	Buddy	Boat	Class	70'	70'
SC 5	28	Trained Some Experience	Trained Some Experience	Buddy	Boat	Recreation	90'	12'
SC 6	40	Not Trained Some Experience	Trained Moderate Experience	Buddy	Boat	Recreation	45'	Surface
SC 7	50	Trained Experienced	Trained Experienced	Buddy	Boat	Recreation	90'	Surface
SC 8	37	Not Stated	Not Available	Solo	Beach	Recreation	50'	Not Stated
SC 9	59	Trained Experienced	Trained Experienced	Trio Separation	Beach	Recreation	Not Stated	Surface

TABLE 1

PROVISIONAL REPORT ON AUSTRALIAN DIVING-RELATED FATALITIES 1986

WEIGHT LBS.	BELT ON?	CONTENTS GAUGE	BUOYANCY VEST	REMAINING AIR	EQUIPMENT CHECK	EQUIPMENT OWNER	WET SUIT	SIGNIFICANT FACTORS
Not Applicable	No	Not	No Applicable	Not	Not Applicable	Own Applicable	No	Poor swimmer. Solo 1st use of a snorkel.
Not Stated but near	Not Stated	Not Applicable	Not Stated	Not	Not Applicable	Not Applicable	Not Stated	Acute Gastric Ulcer Stated bleed. Alone others.
18	On	Yes	Yes	>1/2	Yes	Hired	Yes	Acute Illness. Solo. Calm sea. Toxoplasmodia Myocarditis.
Not Stated	On	Yes	Yes Used	>1/2	Yes	Hired	Yes	Knocked over by waves predive. Vest inflated, but drowned.
22	On	Yes	Buddy Inflated	>1/2	Some Adverse	Instructor	Yes	Tight wetsuit. Rough Sea. Night. Lost fins. Hard-breathing regulator. Separation/ solo x 3. Vest inflated.
36	Buddy dropped	Yes	Yes Used	>1/4	Yes	Instructor	Yes	Several health problems. Acute Illness Underwater. Cardiac. Valiant buddies. Weight belt!!
Not Stated	On	Yes	Yes Fail	Nil	No	Hired	Yes	Low-air descent. Out-of-air ascent, air embolism. Current No Air = useless buoyancy vest.
Not Stated	On	Yes	Yes	Low	Yes	Hired	Yes	Post swim surface unconscious (possibly) Air Embolism.
21	Off Entangled	Yes	Slightly Inflated	Low	Yes	Club Instructor	Yes	Underwater onset feeling ill? Surface breathlessness before. Acute Cardiac Failure.
35	On	Yes	Not Inflated	Nil	Some Adverse	Own	Yes	26 cu ft tank. LP Hose to suit vest not connected. Out-of-air.
Not Stated	Buddy dropped	Yes	Slightly Inflated	>1/2	Some Adverse	Own	Yes	Surface separation, calm sea. Buoyancy vest inflation support, unconscious face down.?? Cardiac.

CASE	AGE	DIVE SKILL LEVEL VICTIM	BUDDY	DIVE GROUP	DIVE BASE	DIVE PURPOSE	WATER DEPTH	INCIDENCE DEPTH
H 1	26	Not Trained Some Experience	Not Trained Experienced	Separation	Rocks	Shellfish	10'	10'
H 2	31	Not Trained Some Experience	Not Trained Inexperienced	Separation	Boat	Crayfish	12'	5'
H 3	34	Trained Experienced	Not Available	Solo	Wharf	Work	37'	25'

first a delay in the getting together of those involved, then faults which caused both outboard engines of their boat to fail. But they both held licences to catch crayfish and were determined to go diving. So they took their compressor and other diving equipment in a car down the coast in search of a suitable place for a dive using hookah. The car became bogged on the coastal track but nearby they found a place where their compressor could be located close to the water. The buddy was untrained but had experience of many years of diving. He had trained the victim and the third one in the group, the person deputed to remain with the compressor. The victim was said to have made 15 dives in the previous two years.

They were careful to site the compressor correctly before connecting their hoses and entering the water. After about thirty minutes the buddy came ashore to sort his catch for correct sizes and about 5 minutes later the victim surfaced 15-20 metres out. He showed no signs of having any problems, and he soon resubmerged and his bubbles showed he was swimming towards the shore. He surfaced again a short time later, however, and signalled to them to pull on the air hose to assist his return. They had arranged to give this help on request when planning the dive so the two who were ashore started to pull in his hose. They saw him submerge and noticed an increased resistance to their efforts, then he came to the surface again and seemed to be in some kind of trouble and was calling to them for help, but the compressor was so noisy they could not make out what he was saying. He seemed to be struggling rather than to be panicking. The buddy thought that he might be entangled by the kelp and rapidly donned his mask, fins and weight belt and grabbed his regulator, then jumped into the water. He was brought up short by inhaling water, having omitted to put the demand valve into his mouth before entering the water, then lost a fin and while placing it back on was inconvenienced when his companion turned off their noisy compressor in order to hear what the victim was calling. It was soon ordered restarted!

When the buddy reached where the victim had been, he found him lying on the sea bed, the water depth here was only 10 feet, with his regulator free flowing nearby. He was in a clear area and not entangled when found. The buddy managed to remove his weight belt with some difficulty due to the quick release having been pulled, possibly by their hose traction, to lie at his back (and therefore out of the victim's reach). After he had surfaced with the victim he signalled to be pulled ashore by his hose but the person there mistakenly pulled in the victim's hose. This one, ditched in order to make it easier to raise the victim, was composed of two lengths and the junction parted during this time of pulling, an event that had no adverse influence on this occasion but highlights the real danger of pulling too hard on a hose junction. Realising what was happening, the buddy towed the victim back to the rocks. Their EAR efforts were unavailing. The cause of death was drowning with no explanation for the observed events. It is supposed that his hose became snagged round kelp or some other obstruction and he became tethered, sank, let the regulator fall from his mouth, was unable to recover it or to reach the quick release of his weight belt so he drowned despite the shallowness of the water. Aid was summoned using the radio on a boat which came to the scene during the rescue.

UNTRAINED. SOME EXPERIENCE. SEPARATION/SOLO. HOOKAH. SHALLOW CALM SEA. NO BUOYANCY VEST. WEIGHT BELT TURNED SO QUICK RELEASE OUT OF REACH FAILED/UNABLE TO DROP WEIGHT BELT. PROBABLY HOSE ENTANGLED BY KELP. AIR HOSE SEPARATION ON TRACTION. DIFFICULT ACCESS FOR AMBULANCE.

H 86/2

This man was untrained but had been diving for many years and had instructed his friend in the art and science of using the hookah apparatus about 5 months prior to this incident. That they both regarded 25 fsw as deeper than they

WEIGHT LBS.	BELT ON?	CONTENTS GAUGE	BUOYANCY VEST	REMAINING AIR	EQUIPMENT CHECK	EQUIPMENT OWNER	WET SUIT	SIGNIFICANT FACTORS
21	Buddy dropped	Not Available	No	Not Available	Some Adverse	Borrowed	Yes	? pulled underwater as air hose around kelp. Unable ditch weights.
23	Buddy dropped	Not Available	No	Not Available	Faulty	Borrowed	Yes	Repeated diving after repeat hookah failures. Hose snagged.
27	On	Not Available	No	Not Available	Yes	Employer	Yes	Aware danger, used scrubber. Emergency so cut own airhose. Failed operate get-home tank.

were experienced to dive indicates a cautious and limited approach. The weather had lately been unsuitable but this day the sea was calm. Then the buddy found his boat was not working and his hookah was bolted to it. However he had a friend with a compressor designed for diving though till then it had only been used to inflate car tyres and spray paint. The friend had however loaned it recently to a diver who was an engineer and he had overhauled it before returning it. So it was said to be now in perfect working order. The hookah owner was a trained scuba diver and brought his wife along on this trip intending to teach her to scuba dive while the others were hookah diving from his boat.

They declined the first dive location because of the poor visibility, they hit the sea bed before they could see it. A shallower location was then tried. The visibility here was also far from good. The victim and buddy descended but soon had to surface as the compressor motor cut out. It was easily restarted but soon again failed. Again they surfaced but descended once more when the owner, the scuba diver, restarted it. He had thought that would abandon their attempts to dive after this and did not notice them dive again as he was busy handing a scuba tank out of the boat to his wife, who had been snorkeling around the boat while the engine problem was occurring. Then the engine failed again but on this occasion it refused to restart. This time the buddy alone surfaced.

When he surfaced the buddy called out that the victim was trapped, prevented from surfacing by his air hose. He had tried to pull him free but failed. The victim could be seen 5 feet beneath the surface, his hose passing under a rock ledge and tethering him about a similar distance from the sea bed. The buddy realised the necessity of setting him free and breath hold dived again, on this occasion managing to release the weight belt and bring him to the surface. He was still alive at this time with frothy blood coming from his mouth. The buddy and the scuba diver commenced EAR while towing him back to the boat and continued this during their 10 to 15 minute trip back to the harbour. There he was pronounced dead.

The compressor was attached to a single air hose and this ended at a "T " junction from which ran two 15 feet long hoses, one to each diver's regulator. The hose section running to the victim had caught under a ledge and unfortunately it failed to pull free when he ascended. He probably responded by struggling against the restraint it imposed instead of ditching his weight belt, too late realising his mistake. Although the scuba diver member later said he had noticed that the victim had the air hose covering the belt quick-release, the buddy reported that the only problem he noticed in releasing the weight belt arose from him wearing rubber gloves, to protect his hands while catching crayfish, as these made his attempts to operate the quick-release clumsy.

Examination of the compressor's engine revealed that the carburettor drain tube had been incorrectly connected. It was upside down and therefore permitted the carburettor to over-fill. When this was corrected the engine worked properly. It was lucky for the buddy that the water depth was not any greater or he also might have found himself tethered. The inexperience of the victim was tragically demonstrated by his failure to respond by dropping his weight when snagged so close to the surface. As the hose and the regulators were ditched during the rescue and were stolen before their recovery was arranged, this equipment was unavailable for checking but there is nothing to suggest that it was faulty.

UNTRAINED. INEXPERIENCED DESPITE MANY HOOKAH DIVES. SHALLOW WATER. CALM SEA. CONTINUED DIVING DESPITE REPEATED COMPRESSOR FAILURES. SINGLE AIR HOSE TO "T" JOIN THEN TWO SHORT HOSES TO REGULATORS.

HOSE TRAPPED BENEATH ROCK LEDGE. TETHERED VICTIM UNABLE TO SURFACE FAILED TO DITCH WEIGHT BELT. SCUBA DIVER TEACHING NOVICE TO DIVE IN OPEN SEA. SEPARATION/SOLO DIVE.

H 86/3

After leaving the navy this diver took up commercial work and was involved in tasks such as scrubbing the hulls of vessels. He was regarded as being safety conscious and on this occasion he was using a hired hull-scrubber to work on a ship in harbour. The machine was known to have gobbled up a diver's umbilical at least on one previous occasion when used by his team but the installing of an emergency cut-out switch for the diver to use was quoted at so high a price that it was not installed. A simpler, and cheaper, remedy of binding the umbilical to the power cable, at least close to the machine, was suggested but never implemented on this job.

The diver had voice communication with topside, one person to monitor the communications, one as tender, and a third to ensure the hose did not snag as the diver worked fore and aft under this ship close to the wharf, this last being the stand-by diver. After a short time underwater the communications failed so while it was being repaired the diver was brought out of the water. After this the victim, the boss, decided that he would take a turn working the scrubber and exchanged tasks with the first diver. The wharf crew became alarmed when communications ceased abruptly and the tender noticed the hose was suddenly taut. They immediately cut power to the scrubber and the stand-by diver descended along the umbilical to find out what was wrong. He found the hose led to the scrubber and entered it but there was no sign of the victim. The visibility was nil but he noted that the hose had been cut. A search was now organised and his body was located five hours later. His fullface mask was full of water but the back-up bottle he was wearing soon blew this out. It is believed he cut his hose in order to prevent himself from being drawn inexorably into the scrubber but did not have time to turn on his reserve air bottle to establish positive pressure in his helmet before it filled with water and he drowned as water entered through the cut hose. The hose was of a floating type and under the hull would be likely to be near the intake for the scrubber.

COMMERCIAL DIVER. SCRUBBER KNOWN RISK INGESTING HOSE. FAILED TO TIE HOSE UMBILICAL TO POWER LINE OF SCRUBBER. UNDER HULL WITH FLOATING TYPE HOSE. GET-HOME CYLINDER BUT DROWNED WHEN CUT HOSE TO STOP BEING PULLED INTO MACHINE. MACHINE DANGEROUS IF USING HOSE SUPPLY.

DISCUSSION

Examination of these cases reveals many matters which are of importance in the context of diving safety but major attention is warranted to two matters in particular, the fact that a medical factor was so frequently present and the number of cases where a buoyancy vest failed to save its wearer. In the first group there is no suggestion that the victims were necessarily aware, or could have been aware, of their precarious health condition. Certainly a medical examination would not have predicted these disasters. The situation may be that the number of people diving is now so great that a statistical expectation arises that illness-related deaths will occur in sufficient numbers to invite comment. There must be many unfit persons undertaking all types of activities and only a small number will become fatally ill. It would be helpful in this context if an increased attention were given to investigating the medical history of victims, but there is a high probability that a person undertaking diving or other potentially strenuous activity will be unlikely to tell others of any symptoms he suspects might lead them to advise him to refrain. Case BH 86/3 may serve as an example of a person who probably had some symptoms of indigestion but in whom it is unlikely anyone would have predicted that there would be an acute gastric haemorrhage, and his medical history was not ascertained. The "cardiac deaths" noted in Cases SC 86/1, 86/4 and 86/7 (and possibly in SC 86/9) were all probably "unavoidable deaths" and would have occurred even had the victims been at home, but there is no way such a proposition can be tested. Although it was obvious that the victim in Case SC 86/4 was considered unfit, so received special attention, nobody suspected that his heart was his danger factor, his hypertension being considered not requiring medication. This case also serves to remind us "even Homer nods", that the dicta of experts may be suspect. The pathologist was too ready to regard all in-water deaths as necessarily resulting from drowning, although in this case he was tactfully persuaded to look at the evidence again and reconsider his diagnosis.

Of greater importance is the finding that an unconscious person may drown despite wearing an inflated buoyancy vest, a fact which is disquieting and deserves urgent attention. There is also a fact noted previously, that an empty tank makes scuba-feed vests virtually useless in time of need. Obvious, but nonetheless having real significance and likely to be overlooked by wearers until an emergency situation occurs.

The death in Case BH 86/1 illustrates the effect of using unfamiliar equipment, in this case the victim would have survived if he had thrown away his snorkel and thought of himself again as a swimmer rather than some breathing through a tube. The other breath-hold fatality underlines the sad fact that one is alone in a crowd, that supervision of an unregulated group is not possible. It is for such a reason that the instructor and pupil ratio has to be kept low, particularly in the open water phase of teaching scuba.

Fatalities among hookah users usually result from failure of the compressor portion of the apparatus or from a hose problem of some sort. In these cases there was hose entanglement and hose separation as well as a cut hose and compressor engine failure. A sad collection of reminders of the critical factors deserving the keenest attention by hookah users.

Readers are invited to consider what further lessons they can discover from a careful consideration of these case histories so that such events never confront them or their buddies.

ACKNOWLEDGEMENTS

The production of this report would not be possible without the interest and support of the Departments of Attorney General/Law/Justice in every State. The willing assistance of the Police in cases where the Coroner has considered it not necessary to hold any Inquest is noted with appreciation. Thanks are also due to those in the Diving Organisations, as well as those who correspond directly, for their support.

PROJECT STICKYBEAK

The objective of this project is to collect reports on all types of diving-related misadventures which range from the fatal to those so well managed that there was no "incident" to report. Medial Confidentiality is at all times afforded such reports, and there is a firm policy that this is a NON PUNITIVE REPORTING SCHEME. This means that the reporting of asthma or diabetes, etc., will NOT result in the affected diver losing his or her diving certification. Remember, it is only through having accurate, adequate, and up-to-date information that diving and hyperbaric activities are able to reach and maintain acceptable levels of safety. Reports are urgently required to enlarge the scope of the project.

Reports should be sent to:-

Dr Douglas WALKER,
P.O. Box 120,
NARRABEEN,
NEW SOUTH WALES 2101.

By Ed SPUMS J.

The following paper highlights the unknown, and unknowable, factor in all calculations about the risks of diving, the denominator. Diving trainees can be counted but not the number actually diving during any weekend, nor the total of divers and dives made during a year.

The situation in Australia is little different. The various diver training organisations know how many certifications they have issued each year, and there are estimates of the number of dives a week out of Cairns. But the dropout figures are not known nor is the number of dives a year by "active divers" known.

We have reprinted the paper to encourage all diving organisations, dive training bodies, diving clubs, and individual divers to keep records of who dives when, and to encourage them and dive charter boats, who presumably keep records of divers taken out and their dives, to supply Project Stickybeak with annual figures. As with all Project Stickybeak information it will be confidential and all identifying items will be removed before the information is used for publication.

Of interest is the total number of dives in the year and each diver's total, or in the case of charter boats the number of dives by each diver on the charter. With this information for Australia our statistics would no longer only be guesses as we would have a minimum number of dives a year, and with luck, an estimate of dives per diver.

THE RISKS OF SPORT DIVING

Robert Monaghan

JUST HOW MANY DIVERS ARE THERE ?
3.5 Million or 700,000?

INTRODUCTION (By the Editor of "Undercurrent")

Diving is purported to be a very safe sport, especially when compared to other sports. The truth is, comparatively speaking, it may be among the least safe because the number of active divers may be far fewer than popular industry statistics would have us believe.

Diving fatality and accident rates are determined by the National Underwater Accident Data Center (NUADC), which is housed at the University of Rhode Island. It is essentially a one-man operation, which John McAniff has dutifully compiled and reported data since 1970. Historically it has been underfunded by the federal government, and now barely survives on a budget of less than $60,000 per year, mainly through large contributions from the Diving Equipment Manufacturers Association, PADI and small contributions from others, Undercurrent included.

Although NUADC reaches out to a number of sources for information about diving deaths, according to its own statistics about 75% of the deaths it discovers comes from newspaper clippings provided by a clipping service. John McAniff has told Undercurrent that the NUADC has never received complete data nor complete cooperation from the training agencies or other industry sources to develop a statistical base. Essentially, McAniff labors alone *to arrive at his estimates of the number of divers and the number of deaths.*

NUADC's figures generally leads it to conclude that diving is becoming a safer sport. The industry relies on those figures to publicize the safety of diving, and has demonstrated no interest in investing in any further research because it can claim that each year sport diving is becoming safer.

The starting point in NUADC's analysis is its estimate, today, of "3.5 million active sport divers". In trying to get a better handle on the numbers, we had a discussion with Robert Monaghan, a 35-year-old PADI master instructor who is completing his work on his doctoral dissertation in physical anthropology at Southern Methodist University. Monaghan, who has had doctoral-level training in human population modelling and statistics, has made a formidable effort to develop a census model of participation and safety in the industry. Although his approach is at times tedious, we present it all so that anyone wishing to mount a challenge can see exactly how his conclusions are derived.

HOW MANY ACTIVE DIVERS ?

In this two part article, we will look at some of the problems which underlie the statistics presented by the National Underwater Accident Data Center.

I will demonstrate that there is only one-fourth of the number of "active" divers claimed by NUADC.

I will discover that the number of reported deaths may be less than the actual number.

We will find that today's divers are making only one-third as many dives as divers of just a decade ago.

And, I will conclude that diving is not as safe a sport as is claimed.

"Active" Divers Versus Real Divers

To begin to understand the death rate, one has to know just how many people actually dive. In the November issue of *Underwater USA*, John McAniff was quoted as saying that "there are over 3.5 million active divers". To NUADC, an active diver is someone who dives "at least three times" a year. In NUADC's last formal report, which covered deaths in 1983 and 1984, the claim was:

"Based on information obtained from all of the national training agencies, there have been approximately 5.48 million divers certified sine 1960. Allowing for dropouts, cross certifications, etc., the NUADC is now estimating the active diver population in the United States at the end of 1983 at 2.6 million active divers, and at the end of 1984 at 2.7 to 3 million divers. Based on the above information and numbers of fatalities per year, we find that 1983 had a fatality rate per 100,000 of between 3.78 and 4.07 and in 1984 the fatality rate would be the best ever recorded by the NUADC at 2.33 to 2.59 fatalities per 100,000 active divers. These figures support the position that diving is becoming safer, especially when compared to the peak year of fatalities, 1976, in which year the NUADC reported a rate of 8.62 per 100,000."

These figures are open to question judging from available data.

In the early 1970s several organizations (including NUADC in its report No7 and the National Oceanographic and Atmospheric Administration in a 1975 report entitled "An Analysis of the Civil Diving Population of the United States") estimated diver population at roughly 500,000.

In 1976, NUADC estimated 1.7 million divers, a figure requiring a 1.2 million jump from 1970. Industry figures (see chart 1) suggest that as many as 1.3 million divers were certified in that period, but NUADC's figure allows for only 100,000 dropouts during those years.

The industry itself, as Al Hornsby reports in the *PADI Undersea Journal* in 1983, uses "a standard dropout rate of 80% a year," which means that 80% of the divers certified in any given year drop out of diving within the next 12 months. In that article, Hornsby went on to say that the PADI rate is better than that.

In a preliminary 1981 report on 1979 diver fatalities, NUADC estimated there were 2.3 million "active" divers. That means 600,000 more active divers than there were reported in 1976. The industry may have certified as many as 800,000 during that period, but NUADC only acknowledges 200,000 drop outs, or 1/4 of the divers certified over three years.

Curiously, NUADC sees a 400% increase in the number of divers between 1970 and 1979, yet during that period industry figures show almost no economic growth in the diving industry. From 1974 to 1980 the total real growth of the diving industry was "a pathetic 2.5%," reported Alex Brylske in the PADI IDC Candidate Workbook.

If there was a 400% increase in "active" divers, the latter did not buy much dive gear. The diving industry's lack of growth would seem to preclude a 400% increase in the number of "active" divers. The truth is that growth is slow because as many as 80% of the newly certified divers drop out one year after being certified or, if they do not drop out entirely, dive a couple of times a year or two later, then give up the sport. However, NUADC's figures do not seem to take this into account.

Certification Shell Game?

Let us begin with an initial 463,000 diver population.

CHART 1
MONAGHAN MODEL

DIVING INDUSTRY DEMOGRAPHIC MODEL, NEW DROPOUTS 80%, EXPERIENCED DROPOUTS 10%

Year	Population	Experienced Dropouts	Certifications	New Dropouts	New Divers
70	463000				
71	449700	46300	165000*	132000	33000
72	448130	44970	217000*	173600	43400
73	446717	44813	217000	173600	43400
74	445445	44672	217000	173600	43400
75	443501	44545	213000*	170400	42600
76	443151	44350	220000	176000	44000
77	442836	44315	220000	176000	44000
78	442552	44284	220000*	176000	44000
79	444297	44255	230000	184000	46000
80	447867	44430	240000*	192000	48000
81	455080	44787	260000	208000	52000
82	464972	45508	277000*	221600	55400
83	483275	46497	324000*	259200	64800
84	506948	48328	360000	288000	72000
85	532253	50695	380000	304000	76000
86	559028	53225	400000*	320000	80000

NOTE: *Is published estimated of certifications, others are interpolated. An error of 10,000 in estimate yields a declining error under 2,000.

That figure is based mainly on a NUADC study (report No7) published in 1972. This is a maximum estimate since it includes some snorkellers and commercial divers as well. Other studies support an estimate of up to half a million by 1970, but that slight increase would have no material change in the outcome of our model so we will stick to NUADC.

By gathering certification statistics from various agencies, we're able to look at growth in number of certified divers (see chart 1) from 165,000 certifications in 1971 to 400,000 certifications in 1986. We find that a total of 3.93 million people were certified in those 16 years. Added to the 463,000 presumed to be actively diving in 1970, the total is 4.53 million people who became certified divers through American agencies.

Drop-out rate

We can estimate the maximum number of active divers by using training agency and industry estimates of an 80% drop-out rate of new divers at the end of one year. NUADC itself used a similar figure in their report on 1972's statistics: "The major training organisations estimate the 'dropout' rate in recreational diving at the end of the first year to be as much as 75 percent.

A widely quoted diver survey, the Graham study, (a 1975 San Diego State University master's thesis), supports this high dropout rate analysis. Study of statistics revealed by PADI also may support this high dropout rate (worst case analysis of basic diver dropout is reported to be as high as 70%, in Al Hornsby's "Latest Trends" PADI IDC Candidate Workbook 1984).

NUADC now claims to use a 45% dropout rate, although the rest of the industry apparently continues to use 80%. In the preliminary publication of 1979 fatalities, NUADC stated that "200,000 newly certified divers/year, minus dropouts result in 135,000-150,000 new divers yearly". That's a dropout rate of 25% to 32.5%, but it does not allow for any additional drop-outs later. If a diver has not dropped out after one year, he is counted for life.

But experienced divers stop diving all the time and, as the diver population gets older, the dropout rate will increase. We know from *Skin Diver* magazine surveys that their average actively diving reader had 4.7 years of diving experience (Bassett, "Taking the Risk of Decompression Sickness", *Undercurrent* , July 1987). Some surveyed divers were newly certified. Others were about to drop out.

CHART II
BASED ON NUADC FIGURES

DIVING INDUSTRY DEMOGRAPHIC MODEL NEW DROPOUTS 45%, EXPIENCED. DROPOUTS 10%

Year	Population	Experienced Dropouts	Certifications	New Dropouts 45% dropout	New Divers
70	500,000				
71	540,750	50,000	165,000	74,250	90,750
72	606,025	54,075	217,000	97,650	119,350
73	664,773	60,602	217,000	97,650	119,350
74	731,250	66,477	217,000	97,650	119,350
75	775,275	73,125	213,000	95,850	117,150
76	819,000	77,275	220,000	99,000	121,000
77	858,100	81,900	220,000	99,000	121,000
78	893,290	85,810	220,000	99,000	121,000
79	930,461	89,232	230,000	103,500	116,500
80	969,415	93,046	240,000	108,000	132,000
81	1,015,474	96,941	260,000	117,000	143,000
82	1,066,277	101,547	277,000	124,650	152,350
83	1,137,850	106,627	324,000	145,800	178,200
84	1,222,065	113,785	360,000	162,000	198,000
85	1,308,859	122,206	380,000	171,000	209,000
86	1,398,000	130,859	400,000	180,000	220,000

This chart uses NUADC's estimate of a 45% dropout, which leads to a maximum of 1.4 million divers at the end of 1986 (multiple certifications are double counted).

But the overall average was only 4.7 years' experience.

Let us generously assume that the average diving career is roughly twice this figure, or 9.4 years. Surely, some people dive many more years, but they are easily balanced by those who drop out earlier. From a ten-year diving career, let us infer a straight-line dropout rate of 10% annually for experienced divers, which, by the way, is about the same for the instructor population.

A study by PADI (Hornsby, *Latest Trends*) from 1980-1982 supports the estimated experienced diver drop-out rate of ten percent, 11.3% of the sampled divers at all levels considered themselves dropouts. Because this sample included some divers certified within the previous year, we would expect the experienced diver dropout rate alone to be less than the quoted 11.3%. The estimate of 10% seems well supported.

How many Active Divers are there?

We can now construct a model, using the 4.53 million as the number of people who have been active in the sport or certified between 1970 and 1986.

We can presume that roughly 80% of the new divers will drop out at the end of each year and 10% of the experienced divers will continue to drop out annually. So, if we take:

The old population, i.e. those active last year.

The experienced dropouts, i.e., that 10% who will drop out between last year and this year.

The new recruits, i.e., those who get certified this year, less those who drop out, we have:

New Population = Old Population - Experienced Dropouts + New Recruits

Chart 1 estimates that at the end of 1986 there were 559,000 active divers.

And, if we were to use an even more conservative dropout rate of 75% rather than 80%, the model would show no more than 700,000 active divers. We have also considered that 80% of the divers drop out in the first 12 months of their training, but perhaps not in the same calendar year. That might mean that at any given moment there are 50,000 or so more divers than the model suggests.

NUADC claims that their starting point of 463,000 divers was for 1967, even though other sources cite that figure as a 1970 number. Even if that were the case, this would make the total less than 800,000.

But consider what is left out. In these certification figures are included multi-agency certifications which the agencies fail to eliminate in their reporting. If the basic diver gets both a NAUI and a PADI card, he is counted twice. In addition, some agencies apparently include advanced certifications in their statistics. Certifications beyond the open water level now account for at least 10% of the totals and are expected to reach 20% shortly.

In fact, although our model used 400,000 for the certification figure for 1985, the *Harvard* report (see *Undercurrent,* May 1987) says that out of 400,000 total certifications in 1985, only 240,000 were *new* divers; of the 265,000 PADI certifications awarded in 1985, for example, 160,000 were estimated to be new divers.

So, let us use the more conservative 700,000 in our future calculations, although 559,000 predicted by our model may itself be generous.

If the industry is to maintain a constant 700,000 active divers, then the agencies must certify 350,000 new divers annually just to stay even.

But the industry continues to proclaim active diver population figures five times higher. When:

The fatality rate = number of fatalities / number of divers

is it possible that some people may believe it makes business sense to keep that denominator as high as possible?

In the next issue, we will see just what these totals mean regarding diver safety. Is scuba diving the safe sport we all claim it is?

Undercurrent Comments:

We asked for a publishable response to the Monaghan article from NUADC, and received a lengthy letter addressing the article but it was specified that it was not for publication. We have used some of that material to correct Monaghan's original draft. The biggest criticism was directed at the dropout rate, which Monaghan assumes a 75-80% rate, while NUADC assumes a 45% rate (no reason other than "extensive investigation" was given by NUADC for selecting this rate. One must remember that the agencies do not cooperate with NUADC).

For the sake of good sportmanship, we repeated Monaghan's model using the suggested 45% dropout rate, with a starting point of 500,000 divers in 1970 (Chart 2). As you can see, it predicts 1.4 million active divers at the end of 1986 (NUADC claims 3.5 million in November 1987). Of course, this projection still double counts multiple certifications, without which the total could easily drop well below 1 million. If Monaghan has underestimated the population of active certified divers, it is most likely by less than 300,000.

Finally, we can conclude this first part by mentioning two other industry estimates. Paul Tziumoulis, publisher of Skin Diver, told Undercurrent that they assume an active diver market of roughly 1.1 million when promoting their magazine. And the National Sporting Goods Dealers Association has published a study in which they say that in 1985, 1,254,000 Americans made one or more dives; in 1986 that number had jumped to 1,617,000. Presumably, these figures include all those people who took resort course diving or were in training.

IS DIVING GETTING SAFER ?

Just How "Active" Is "Active"

In the last issue I noted that NUADC defines active diver as someone who makes "at least three dives" annually. It seems quite a stretch to consider a person making so few dives as "active", but that has become the acceptable industry definition.

The NUADC figures which show that diving is getting safer are based on a growth in the number of divers. But today's divers are apparently making far fewer dives than did their counterparts in the mid-1970's, when diving was the central recreational aspect of most divers' lives. Today, diving is more of a family sport. More women are involved. And a much higher percentage of divers do their diving on one vacation a year, rather than on weekends near their home. The result is that typical divers today make fewer dives than did divers ten years ago.

In fact, the typical diver today may be making 40%, or even 65%, fewer dives per year than ten years ago.

Skin Diver magazine annually surveys its readers. In the 1970's, their survey found that each subscriber went diving an average of 25.4 times per year. ("Times" is a day of diving, which *Skin Diver* has determined statistically to be about 2.1 dives, or roughly 53 tanks per year.) By 1980, that figure had declined to 19.1 times. (A 1980 *Sport Diver* survey had a figure of 15.1, and the 1981 *DEMA Report,* prepared by the independent Harvey Research Organisation, came up with a figure of 8.7 times per year.) In 1983, *Skin Diver* subscribers reported that they spent an average of 15 days diving. The 1985 report does not report a number for the average number of diving days.

Granted, the nature of the typical *Skin Diver* reader could have changed dramatically in those ten years, leading to invalid data. On the other hand, this drop in average number of dives seems to make sense. Where ten years ago, about the only diving most people could afford would be diving in their home state, today hundreds of thousands of people of all ages have been certified (a high percentage at tropical destinations) solely for the purpose of diving on vacation. With great numbers of older people and vacationers being certified, it is no wonder that the drop out rates remain high and the average number of dives has dropped substantially.

So, the conclusion here is quite fascinating: 700,000 active divers seem to be making about 40% (and perhaps even 65%) fewer dives than did their counterparts ten years ago.

With annual experience down from 25 to 15 days of diving (or to 8 days, if we use the *Harvey* report) today's typical diver is significantly less experienced than was his counterpart ten years ago.

And where the typical diver ten years ago was more likely to brave the more difficult waters of California or the Great Lakes or elsewhere, the percentage of total dives being made in those waters today has declined markedly.

If one wishes to argue that today's less experienced divers are safer divers, it is only because an increased percentage of dives being taken are in warm and clear tropical waters with divemasters or guides present.

It is the dramatic change in the number of dives per individual and the conditions under which they are being conducted which have helped the actual number of annual deaths to decline since 1976.

Even so, the fatality rate is not as low some people claim.

Unreported Deaths Are A Minimum Estimate

The NUADC has itself estimated that during the 1970's there might be up to 10 unreported deaths each year in the U.S. and we can accept that. Furthermore, we would argue that the number of deaths of American divers in foreign waters is also reported inaccurately.

The NUADC data collection system is not adequate for accurately determining diver deaths abroad. Although the NUADC director, John McAniff has written to *Undercurrent* that he has "10,000 contacts who are solicited for information by mail at a rate of about 1000 letters, three or four times per year", certification agencies, resorts, the travel agents, and foreign governments do not systematically report deaths to NUADC. And U.S. newspapers, from which NUADC receives 75% of its death notices, do not report all foreign deaths (injuries and deaths in Mexico are notoriously under-reported). With no formal reporting system, NUADC must rely upon voluntary reports, mainly from unofficial sources. NUADC, with limited resources, does the best it can to collect these statistics, but we must expect foreign deaths to be seriously under-reported and that gap will increase as diving travel increases.

Nevertheless, we will simply accept that notion that the reported fatality figures are about 10% short of reality.

NUADC charts show 532 deaths of American divers in a five year period: 482 in the U.S., 31 in the Caribbean and 19 in the rest of the world. For the purpose of this analysis, we will kick that up 10% to 585, or 117 per year.

Has Diving Gotten Safer?

We can now take a closer look at claims that diving has gotten safer.

In 1976 the number of deaths peaked at 147. We have shown that there were roughly 25.4 days of diving per diver per year times 2.1 dives per day, or more than 53 dives per diver per year. That figure suggests about 26 million dives overall for that year.

The ratio of deaths in 1983 (the last year for which we have participation statistics) to 1976 is 110:147, that is, 1983 had 25% fewer deaths than 1976. But, as we have shown earlier, divers are making far fewer dives. 15 million in 1983 to 24 million in 1976, or 38% fewer. If each of today's dives were as safe as those of 1976, we would expect a 38% reduction in the number of deaths from 1976, or 91 deaths. Yet we reported 110 deaths. Analysis of other years will show some ratios about equal, which still does not permit the argument that diving is getting safer. Yet, if one wishes to persist with the belief that diving is getting safer, one must acknowledge that it is only because it is increasingly being conducted in warmer tropical waters under carefully controlled circumstances.

It would be difficult to make the case that it is due to better training or greater experience.

Risk Assessment

We can make our own risk estimates using the number of estimated total diving deaths of 117 and the predicted number of 700,000 real divers. Using our figures, the rate of death among those real divers is 16.7 deaths per 100,000 divers (117/700,000).

The risk of death would be 117 deaths/11,000,000 dives, or 0.0011% deaths per dive. Taking the reciprocal, we get an estimate of one death per 95,000 dives. Even in the peak death year, 1976, it was more like one death per 132,000 dives. Keep in mind today's average diver only dives 15 dives per year.

Perspectives From Other Sports And Activities

For years, we have been told diving is a safe sport, but how does it really stack up against the others. The 109 deaths NUADC reported in 1980 are 6.4% of the 1,730 recorded U.S. 1980 deaths in all sports, including hang-gliding and parachuting.

The fatality rate of all listed sports is under 1.88 deaths per 100,000 participants. "Safe" sports like football, basketball, waterskiing, and snowmobiling average only 0.22 deaths per 100,000 particpants. In 1980 there were 53 million participants in the "safe" sports of football, basketball, waterskiing, and snowmobiling! Diving, with 16.7 deaths per 100,000 participants, is 75 times more dangerous than these "safe" sports. Furthermore, if we consider how few hours a diver is acutally underwater when compared to the hours a participant is engaged in the other sports, the ratio is even more dramatic.

In comparison with the high risk sports like parachuting or hang-gliding, diving is safer. There are two-fifths as many deaths on a per 100,000 basis compared to hang-gliding, and one-fifth as many compared to parachuting. Diving also seems to have a much lower injury rate.

Some divers are fond of saying that diving is as safe as driving a car. This, of course, is nonsense. Yes, there are fewer deaths per 100,000 divers than 100,000 drivers (16.7 diving deaths versus 19.3 vehicle deaths according to 1984 Census data), but a typical diver conducting 15.1 hour-long dives logs about 32 hours a year underwater, only a tiny fraction of the time that a typical driver puts in behind the wheel.

Why Do We Cling To Erroneous Statistics?

The estimates we have developed here clearly conflict with those commonly used in the industry. In general, we find that there are fewer divers, fewer dives, and greater risk of fatalities.

Why does the industry use erroneous statistics? There are no others.

The only organisation collecting this data, NUADC, has a minimal budget and cannot be expected to locate fully accurate fatality statistics.

NUADC must accept certification data provided by the agencies, without any distinction of duplicate certification. It can only estimate such figures as "active diver" and the "drop out rate". It has no money to conduct research on its own.

By staying with its standard reporting pattern over the years, NUADC does not look at the data any differently today than it did ten years ago. For example, when NUADC uses a base year to compare current deaths to past ones, they always choose 1976 as the year for comparison, the year with the highest level of deaths, 147. If we used the next year, 1977 we would only have 102 deaths and our current levels would not seem like much of an improvement.

DEATH RATE PER 100,000 PARTICIPANTS

SPORT	RATE
PARACHUTING	82.90
HANG GLIDING	43.30
SCUBA DIVING	16.70
BOXING	12.50
SWIMMING	2.44
BOATING	2.36
SNOWMOBILING	0.70
WATER SKIING	0.26
FOOTBALL	0.25
BASKETBALL	0.02

(The source for the non-scuba data is the 1984 Accident Facts, National Safety Council.)

NUADC often issues preliminary statistics, updating them later when all the data is in. The final report inevitably shows more fatalities than the preliminary report. Nonetheless, many people use the preliminary figures and do not update them after NUADC does. For instance, in Nadler's widely quoted article "PADI's Impact on the Diving Industry" (*Undersea Journal*, 3rd Quarter 1984), preliminary figures are used. The rate of 3.63 deaths per 100,000 used by Nadler was raised as much as 15% to 3.89-4.16 deaths per 100,000 when NUADC discovered additional deaths. Of course, we maintain that 16.7 deaths per 100,000 is closer to reality.

Any manufacturer or training agency can cite NUADC figures to insurance companies to demonstrate how safe diving is.

The industry has an interest in presenting a safe image of diving to potential federal, state, or local regulators. A great deal of money is spent to lobby against legislation aimed at regulating diver training. NUADC statistics can be used to convince public officials that the diving industry can regulate itself.

I am not claiming there is collusion in the industry to disseminate erroneous data. I am saying there is no incentive to collect more accurate data. At the time of this writing, no one has been willing to spend the money to do it. It is my hope that this article will lead to accurate determination of the safety of diving, with subsequent moves by the entire industry, training agencies, instructors, dive stores, resorts, divemasters, travel agencies, boat captains, manufacturers and anyone I have missed, to make our sport safer.

Undercurrent comments

We published Bob Monaghan's article with the hope that it will lead to sufficient introspection to fund the collection of more accurate data about the safety of diving, and more cooperation in sharing that data.

Obviously, Monaghan's conclusion that diving is less safe than we have been led to believe can impact all levels of diving, including you, the sport diver.

Yet, we all know that the truth will save lives, most likely by pushing the industry to develop ways to make diving safer. We have all seen newly certified divers come to the Caribbean for their first vacation who are embarrassingly incompetent. We know how much the manufacturers sell regulators by advertising colours, rather than providing information about their capacity to deliver air under difficult conditions.

Yes, the industry does a great deal to stress safety. But it can do much more. It is our hope that this article may provide the impetus. In the long run, inaccurate or incomplete safety statistics are in no one's self interest.

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The address of UNDERCURRENT is P.O.Box 1658, Sausalito, California 94965, U.S.A.

BOOK REVIEWS

Diver Reference Dictionary, pp.131
Best Publishing Co., P.O. Box 1978 San Pedro, California, 90732, U.S.A.
Price US$ 17.50 plus postage & handling $3.75 (surface), $17.00 (air).

It is difficult to identify the target readership for this book but it would seem to be those whose interests in diving matters is a little in advance of their actual level of knowledge and experience. Such a question could be posed with equal validity concerning any dictionary and is therefore of more importance to the publisher than to the reader.

As the anonymous authors admit, they had some problems in deciding which words to identify and define and which to omit. The amazing developments in diving technology in recent years, associated with the publicity efforts of Cousteau and others, have led to a public interested in (relatively) non-technical publications which deal with underwater matters. There has been an unavoidable leaking of formerly "trade" terms into more general usage, though not always into general understanding. This book should satisfy the needs of readers whose chosen authors assume their readers know more about the subject than is the case. As medical terms are included which seem obvious to any doctor it is clear that our communication to divers may commit this transgression too.

The final section of the book is devoted to conversion factors, a fascinating collection of trivia sufficient to destroy whatever naive illusions the reader may still have about the subject of science as exact and international. Having accepted the need to discard inches, ounces, and acres in exchange for centimetres, grams and hectares, it was a shock to find listed 106 equivalents for "psi", 115 for "atmosphere" and an amazing 123 alternatives for "cubic inch". The forces of uniformity still have a long hard slog ahead of them before they can claim final victory over the forces of individuality which mankind continues to show. One can always learn something new from a dictionary!

A Medical Guide to Hazardous Marine Life.
Paul S. Auerbach, M.D. (with photos by the author, Kenneth W. Kizer, Lary Madin, and Carl Roessler).
Published by Progressive Printing Co., Inc., 4505 Lexington Avenue, Jacksonville, Florida, 32210. U.S.A. (Phone: (904) 388-0746).
Price Spiral bound and Perfect bound $US 12.95, Waterproof with Sprial binding $US 19.95..

This elegant new, small (15.5 x 23.0 cm, 47 pp) book has been written for non-medical scuba divers, and all persons who enjoy the marine environment. The author is an Associate Professor of Surgery and Medicine (an unfamiliar combination of expertise in Australasia!), and a Director of the Emergency Department at Vanderbilt University Medical Center. He is Medical Director of the Tennessee Division of Emergency Medical Services, and co-editor of *Management of Wilderness and Environmental Emergencies*. He is currently President of the Wilderness Medical Society, and a main driving force behind the creation of a new international journal named for that Society. His enthusiasm is well known to the reviewer.

The author has tackled the difficult task of writing a concise, non-technical summary of world wide marine envenomation and injury hazards in a creditable manner. He has emphasised immediate first aid measures by those on the spot in a most commendable way; the descriptions of "cleaning wounds", "marine infections", and the control of haemorrhage are splendid (he is an authority on marine infections); and his intelligent description of the place of arterial tourniquts (p. 11) and their limitations is as good as anything the reviewer has read on this subject. There is a thread of practical common sense throughout the text, and the author has obviously been in many of the situations he describes. Advice like "Do not be concerned if the bandage sticks to the wound" (p. 7), and "Almost all bleeding stops with direct pressure. After you begin to apply pressure, don't 'peek' underneath (thus, releasing pressure) for at least 10 minutes, ..." (p. 11) are examples of how he has learned to talk the language of the anxious non-medical diver, and at the same time keep proper practical emphasis. The whole section on "Fish Poisionings" (pp. 34-43) is authoritative, and surely reflects extensive knowledge of, and experience with this subject.

In a book that combines an extraordinary spread of subject matter with resourceful brevity, it is not unexpected to encounter a few controversial areas. The section on jellyfish stings (even allowing for the bias of the reviewer!) is altogether too brief (p. 25). The advice not to apply ice for first-aid pain reduction conflicts with extensive Australian experience to the contrary. The suggestion that "soaks of acetic acid 5% (vinegar)" relieve pain are again in conflict with current research experience. The "species-specific" response of undischarged jellyfish nematocysts to various applications does not seem to be appreciated, although space and brevity make this difficult to tackle. The list of other alternative applications (meat tenderiser, papaya, urine, etc.) advised have been unhelpful in Australian hands, to date.

With present understanding it is not recommended advice to "Release the (compression/immobilisation) bandage after 4 hours, if the victim cannot be brought to a hospital", in the case of Cone Shell or Octopus envenomation. Such a move could result in the (delayed) onset of respiratory failure. (Correctly applied compression/immobilisation bandages may be left on indefinitely, for practical purposes.) It is a relief to see an American author at last recommending compression/immobilisation bandaging, and advising against local incision and suction, for (sea) snake envenomations (p. 33); so it is puzzling to read that a "snake bite suction device ("The Extractor")" should be included in the recommended "Diver's First Aid Kit" (p. 9). The quoted death statistics for "Tetrodotoxin (Pufferfish Poisoning)" , 60% (p. 37), and "Clupeotoxin Poisoning", up to 45% of cases (p. 41), are higher than this reviewer had appreciated.

The photography (all colour) in this little book is spectacular, and together with the intelligent brevity and the "hands-on" authority and common sense that one may expect from an accident and emergency physician, constitutes the main overall impression made upon this reviewer. It contains a Table of Contents, a list of Further Reading, and a useful Index. The text is organised such that each Section/ Topic is relatively complete in itself, and the need for cross referencing is thus kept to a minimum. This facilitates its emergency use. It is available in three forms, Spiral Bound, Perfect Bound, both $US 12.95 and Waterproof with Spiral Binding (the robust complimentary copy provided to the reviewer by the author) at $US 19.95. Postage would be expected to cost about $US 2.00.

As the Introduction (p. 5) states, the recommendations are "current and conservative" throughout, a sensible approach to an enormous and rapidly advancing subject. Sadly, and as indicated by Dr Kenneth W. Kizer in his Foreword (p. 3), the wide ranging and clinically important material in Dr Auerbach's book is rarely taught in medical school. The reviewer hopes this new book will help redress this. Allowing for current differences in Australasian practices, the book is recommended for the first-aid guidance of both the medical and the non-medical scuba diver.

John Williamson.
FFARACS.

Dr John Williamson's address is MSO Box 5695, Townsville, Queensland 4810, Australia

Dr John Williamson, who supplied Dr Auerbach with an advance copy of the above review. has forwarded us the following letter from Dr Auerbach in which he replies to some of Dr Williamson's comments. The letter has been edited .

Vanderbilt University,
Emergency Department,
Section of Surgical Sciencies,
School of Medicine,
Nashville,
Tennessee 37232,
U.S.A.

April 27, 1988

Dear John,

Thank you for sending me a copy of the review of *A Medical Guide To Hazardous Marine Life* that you have submitted to the South Pacific Underwater Medicine Society Journal. I appreciate the time you have taken to write this review and its general positive nature. Just so that you can understand my approach to some of the material which you criticized (politely, for which I am grateful), I offer the following comments.

With regard to the application of vinegar, we have found in the United States that it has a significant effect on pain relief. I understand that it may not work as well for this feature in a *Chironex* envenomation, but as you know we do not encounter those in the States. Certainly, for Portuguese man-of-war, sea nettle, and *Pelagia* stings in the United States, vinegar works quite well.

With regard to not applying ice, our experience has been that ice is generally made from freshwater and application of ice is essentially a freshwater application and causes discharge of nematocysts. Therefore, the person that applies ice runs the risk of worsening the envenomation. If you feel that this is not true, I would like to learn of this, because I do not wish to have my facts wrong.

You are absolutely correct with regard to alternative applications, such as meat tenderizer and urine. These are largely ineffective when compared to vinegar or alcohol and I only mention them in case the preferred agents are not available. In some cases, at least, persons have felt there is some benefit, but essentially I agree with your comments.

With regard to releasing the compression immobilization bandage after four hours, the only reason I mention this is because our experience has been that people inadvertently apply these with too much pressure and create a semi-tourniquet effect, which can be more dangerous than the envenomation. This is a compromise and one that I would certainly be willing to modify if I knew that the bandage had been properly applied.

With regard to the suction device called the Extractor, this does not involve any local incision. It is merely a series of suction cups with a vacuum apparatus that can be applied to a bit wound. It is extraordinarily effective in the management of bee stings and has been shown in studies involving terrestrial snakes to remove up to 30-40% of venom if applied within the first 3-5 minutes of a bite. Therefore, it is not dangerous and may be of some benefit. The obvious problem in the marine environment is that a sea snake bit that occurs underwater would necessitate a delay in therapy as the diver ascends to the surface. However, for someone who is bit while handling a sea snake in a fishing net (which usually occurs on deck) rapid application of the Extractor might be of great value. We are currently recommending that all backpackers and other hikers carry this device when in snake country. This approach is supported wholeheartedly by the research group at the University of Arizona, which includes Drs Findlay Russell and John Sullivan.

The statistics I quoted for tetrodotoxin and clupeotoxin poisoning are from references in my possession. If these are a bit high, I apologize, but that probably is more a reflection of the meager epidemiology in these areas than my attempt to be an alarmist.

Again, thank you for so thorough a reading and review. I always value your opinions and look forward to working with you in the future.

Paul Auerbach, M.D.
Director
Emergency Department

SPUMS ANNUAL GENERAL MEETING 1988

PRESIDENT'S REPORT

I am pleased to be able to report another year of successful activity by SPUMS in its primary objective of providing the requisite national background and support for all underwater activity and sport in Australia and New Zealand. I was almost curious today whether we were an expanding organisation and of course the answer must be yes just as long as underwater activities themselves increase. We must expand to fulfill the needs of the diving population. This year there has been continued growth with 74 new members and 60 associate members.

There have been regional meetings in Cairns in Australia, and in the Marlborough Sounds in New Zealand. Both were very successful. A further regional meeting is being planned for Tasmania in November at Hobart.

The Executive has met at the Cairns-Dive Seminar and in Adelaide in March of this year. The main topics of discussion were the proposed regulatory system in W.A., the venues and speakers for the next A.G.M., the Diploma and an editorial in our journal which provoked a threat of legal action and the need for incorporation that this suggested.

Des Gorman has conducted instructional seminars in Diving Medicine in Adelaide and Auckland, which have been excellent and a tribute to his teaching skills. I can certainly commend them to any of you that have not had an opportunity to take part, whatever the level of experience you may have in the field.

I would particularly like to thank Douglas Walker and John Knight for their work for the society with the Journal which maintains a consistent interesting readability; David Davies for his industry and help as secretary, Grahame Barry for his judicious control over finances, and lastly the staff of Allways for again providing the background organisation for getting us all together here.

Tony Slark

SECRETARY'S REPORT 1987 - 1988

It is with great disappointment that I am unable to present this Report in the flesh. SPUMS has had an eventful year and continues to grow in size, strength and reputation. With only a few days to go to complete the year I have received so far 74 new Membership and 60 Associate Membership applications.

In October, SPUMS sponsored the Cairns-Dive Seminar at which the Executive and several members spoke. This was held to support the local diving medical fraternity and promote diving safety in the Cairns area. Although it was not a financial success it gave us a lot of good publicity in the diving community.

Later in the year, in response to an Editorial printed in the SPUMS Journal, both the Editor and Secretary were threatened with legal action by the promoter of a "diving medical conference". Some rapid investigations confirmed all the accusations made in the SPUMS Editorial. We therefore followed legal advice and refused to either withdraw or make the abject apologies demanded. Nothing more has been heard from the promoter.

This furore did precipitate further discussion about Incorporation and it was agreed to proceed forthwith. Incorporation has been brought up several times over the last few years and this incident was sufficient to confirm the trend. A postal ballot is being conducted to ascertain the members' atitude to incorporation. By 23 May 1988, with over a month to go, I had received 95 (Yes 94, No 1) votes.

Members of the Society have been active in promoting diving safety education too. A Government enquiry was held in Western Australia into the need for legislation to control sports divers. The recommendations have not yet been published but their first step was the publication of pamphlets promoting diving safety. I urge you to watch this closely as other states may follow if legislation is introduced in Western Australia.

PADI has been promoting some research on new diving tables for recreational divers and sent a copy of its findings to several members of the Executive. On your behalf I consulted Professor Brian Hills and Dr Des Gorman and asked their advice. Both condemned the findings as being unscientific, so I was able to convey their thoughts to PADI in America as the official SPUMS response.

For some time a Committee of the Standards Associations of Australia has been convening to formulate a Standard for minimum entry level sports divers. There has been a standard, AS2299, for professional scuba divers in place for some time. This new standard is for the amateurs. SPUMS has not been able to gain representation on this Committee. However, several members of the Executive have made extensive contributions and suggestions based on the draft document. The final result will be interesting to see.

In keeping with its aim of promoting education in diving and hyperbaric medicine, a seminar is being arranged in Hobart in November, in conjunction with the Royal Society of Tasmania. This is being organised by Dr Peter McCartney and several members of the Executive Committee have been requested to present papers on their fields of expertise. I urge all members to attend this seminar and give their support to an active unit that is currently under some administrative pressure.

I should also like to report that a new Hyperbaric Unit has now come "on line" at the Alfred Hospital largely in response to the intense lobbying efforts of Chris Lourey, David Brownbill, John Knight and Des Gorman. This unit was previously located at Morwell in Gippsland but has now been moved closer to the centre of population.

During the year three members applied for the Diploma of Diving and Hyperbaric Medicine. These applications were reviewed by the Board of Censors and it was agreed to award Diplomas to Dr Tim Anderson, Dr Nick Cooper and Dr Michael Davis, and we offer them all our congratulations. This makes the number of Diplomas awarded since 1973, up to 22.

Some communication has been held with the Executive of UHMS over the site and timing of the 1989 Annual Scientific Meeting. Your Executive decided that this should be held in Vanuatu on the week adjacent to the UHMS Meeting so that members of both Societies could attend both meetings.

In conclusion I would like to thank the President and other members of the Executive for their advice and support throughout the year and I look forward to attending the AGM next year.

David Davies

The minutes of this meeting will be published in the next issue of the Journal.

MINUTES OF THE NEW ZEALAND CHAPTER OF SPUMS ANNUAL GENERAL MEETING 1988

held at
Furneaux Lodge, Marlborough Sounds, Sunday, 3rd April, 1988.

The meeting opened at 1920 hours.

Apologies
None. Approximately sixty members in attendance.

Minutes of the previous A.G.M. were circulated.
Accepted. Sutherland/Fraundorfer

Business arising from the minutes.
None

Secretary/Treasurers report dated 30.3.88.

The New Zealand Chapter of SPUMS is registered for G.S.T. purposes - No. 28-566-930. The New Zealand Chapter has expanded to 143 financial members. The financial year now corresponds to the New Zealand one, i.e. 1.4.87 - 31.3.88.

Funds available at A.S.B., Whangarei, New Zealand.

Cheque Account	$ 424.19
Hit Account	$2394.34

New subscriptions are due now:-

Full membership	$50.00
Associate membership	$35.00

(Both inclusive of G.S.T.)

D.P. Johnston, P.O. Box 51, Whangarei, New Zealand, Accountant, has accepted to "audit" the New Zealand Chapter of SPUMS accounts, and will provide an accurate summary in April 1988.
Accepted. Davis/Stephens

It was moved "that the meeting request the New Zealand Chapter executive to look into formalising the relationship with the parent organisation as regards a division of the New Zealand annual subscription".
Passed. Davis/Kenny

President's report.

None this year. Allan Sutherland announced his resignation after many years of hard work.

Election of Office Bearers

President of the New Zealand Chapter.
Peter Chapman-Smith.
Nominated Alan Sutherland, Seconded Mark Fraundorfer.
Secretary/Treasurer of the New Zealand Chapter.
Dr. Andy Veale.
Nominated Mark Fraundorfer, Seconded Rob Stephens.
There being no other nominations the above were declared elected.

General business.

As a result of charitable donation there is a small source of additional funds available to New Zealand Chapter of SPUMS. This is known as the "Founders Fund" and there was some discussion as to a suitable use for these funds. It was moved that the Founders Fund be used in part for the establishment of a library of books and other educational material to be available on loan to SPUMS members.
Moved. Veale/Stephens.

There was some discussion on this point, with the likely site of housing such material being perhaps the NZUA office in Auckland. The Secretary was to house these after initial purchase.
This was carried unanimously.

A remit from Dr. Mills re restricting dive medical examinations to suitably qualified medical practitioners was discussed but in fact the topic had been healthily bashed out at the last A.G.M. and had already been passed.

A letter of thanks was to be sent to John Roy, the honorary cartoonist and a suitable bottle of wine to be presented annually by way of a honorarium.

The Bay of Islands was settled on as the venue for the New Zealand Chapter of SPUMS meeting in 1989 with a likely time of Easter. Beris Ford and others to co-ordinate.

Appropriate thanks were tendered to Carl Edmonds and Ian Lockley, the invited speakers of this meeting, and also thanks to the organising team of Mike Davis, Graham McGeoch, and John Welch. Ciba-Geigy as usual were our ever generous hosts, and Jude Henry as their representative was invited to speak on their behalf.

The meeting closed at 1949 hours.

PRELIMINARY NOTICE

HYPERBARIC AND DIVING MEETING HOBART

November 4 th, 5th and 6th 1988

A meeting on the topics of diving and hyperbaric medicine will be held in Hobart on November 4th, 5th and 6th 1988. The meeting is jointly sponsored by SPUMS, the Royal Hobart Hospital, and the Royal Society of Tasmania, which is oldest scientific society in Australia and New Zealand.

Friday November 4th will be devoted to introductory proceedings. Saturday November 5th will be devoted to diving medicine and Sunday November 6th will be devoted to hyperbaric mecdicine. The organiser, Dr Peter McCartney wishes to hear from all those intending to attend the meeting so that he may planr appropriately.

Topics to be covered include the imaging of bone necrosis, the legal aspects of dysbaric osteonecrosis, CAT scanning of cadavers before post mortems, the "Equivocal bend", anaesthetic administration in hyperbaric chambers, aspects of the treatment of marine injuries, carbon monoxide damage to the brain, medico legal aspects of carbon monoxide poisoning, frostbite and hyperbaric oxygen therapy, hypothermia, lung function tests, diving medicals, "What is needed for a hyperbaric unit in Tasmania", and "Free radical measurement and accurate focussing of hyperbaric oxygen therapy".

The speakers will be from the Royal Hobart Hospital, the Antarctic Division, The National Safety Council of Australia (Victorian Division) and SPUMS members from all over Australia.

This promises to be an excellent meeting and all SPUMS members are encouraged to attend. For further details write to

Dr Peter McCartney,
GPO Box 1317 N,
Hobart,
Tasmania 7001.

A full programme will be published as soon as it is available.

LETTERS TO THE EDITOR

WHY NO JOINT MEETING OF SPUMS AND UHMS ?

66 Pacific Highway,
St. Leonards,
N.S.W. 2065
Ph. (02) 437 6681

Dear Sir,

I have recently been informed that SPUMS have decided not to persue the agreement with the Undersea Hyperbaric Medical Society and have a "back to back" meeting in Hawaii in 1989. The1989 UHMS Annual Scientific Meeting will be held on June 7-11 in Honolulu.

As I attended the executive meeting of the UHMS in 1987, I was well aware, as is everyone else who reads the newsletter, Pressure, that the UHMS welcomed the association and was enthusiastic for this joint involvement.

I feel the decision to withdraw from this agreement, which I understand was also ratified in the international meeting in Sydney early in 1987, is not in the best interests of SPUMS members.

I regret that the executive has not taken this opportunity to strengthen the liaison between the two societies. It is a unique opportunity, one which has not occurred since the inception of SPUMS in 1970, and it could well be another ten or twenty years before the opportunity recurs.

Hawaii is geographically the mid point between the two societies. It would be an ideal opportunity for each to get to know the other, in a superb setting. It has cheap package deals and would allow SPUMS members to be part of an international diving medicine conference.

Why would SPUMS reject the very valid opportunity to conduct an overseas conference in liaison with the international body, thus making the overseas trip plausible to the Taxation Department (not an insignificant factor in 1989)?

If the SPUMS meeting is held at Vanuatu around the same time as the UHMS meeting, the delegate members will be inevitably split between them.

SPUMS members, for the first time, could meet and rub flippers with the greats of diving and hyperbaric medicine. The potential for goodwill and future friendships was astronomical.

One of the real advantages of having the two meetings in the one area, run serially, is that there would be a considerable saving in the transport of internationally famous speakers, as all the great international speakers are already there, and speaking! Instead, SPUMS will probably import one flash of overseas colour, when the rainbow was there for the taking.

And all this is sacrificed for a return visit to Vanuatu!

As an outsider, I regret that such a decision was made and would appeal to the executive to reconsider, for the sake of the societies members.

Yours faithfully,

Carl Edmonds
Director
Diving Medical Centre

The Secretary of SPUMS, Dr David Davies, has provided the following reply to Dr Edmond's letter so that members can appreciate the problems caused by failures of communication

Suite 6,
Killowen House,
St. Anne's Hospital,
Ellesmere Road,
Mount Lawley 6050.
Western Australia

Dear Sir,

Each year the Executive Committee of SPUMS is elected to conduct the day to day running of the Society. To them is entrusted the responsibility of making decisions in the best interests of the Society, although these decisions may be disputed by a minority of members.

During the IXth International Hyperbaric Congress held in Sydney in 1987, the Executive Committee held a meeting to which Leon Greenbaum, Executive Secretary of UHMS, was invited as observor. At that meeting, a suggestion was made that it may be feasible in the future for SPUMS and UHMS to hold a joint meeting at a mutually convenient location. Dr Greenbaum agreed that he would take the proposal back to his Executive. At no time in the discussion was any decision made on precise date or location.

Since that time neither the President nor Secretary of SPUMS has been informed that the UHMS Executive has discussed the subject nor come to a decision. In the interim advice has been received that such a combined meeting is not in the best interests of this Society. When a similar combined meeting was held between UHMS and the EUBS some years ago, the EUBS members found that their meeting and members were overwhelmed by the tidal wave of intense esoteric didactic American hyperbaric research which bore little relevance to practical diving and, especially, recreational air diving. To them, the meeting was a bitter disappointment.

In order to avoid this and perhaps to prevent any ill will, the SPUMS Executive has agreed to hold the 1989 Annual Scientific Meeting at a venue separate from the UHMS Meeting but timed such that members of both Societies can attend both meetings.

Since this decision was made, several letters have been received from Senior members of the UHMS Executive accusing SPUMS of renegeing on a definite agreement between the two Societies. I repeat that no such definite agreement was ever made or confirmed.

It is unlikely, in light of this misunderstanding that the UHMS Meeting will be held so close to Australian shores again for a long time, so I strongly urge all our members to extend their conference tour in 1989 to include both the SPUMS Meeting in Vanuatu and the UHMS in Honolulu. I am writing to Dr Greenbaum inviting his members to attend the SPUMS Meeting and contribute to its scientific program.

I conclude that this unfortunate occurrence has resulted from misinterpretation and perhaps a lack of communication but I hope that at some time in the future a joint, informative and convivial meeting can be arranged so that any differences can be resolved.

David Davies,
Secretary of SPUMS

DIVER HYPOTHERMIA

CURRENT STATUS AND FUTURE CONTROL

Richard F. Taylor and David W. Yesair

In the population at large, hypothermia is mainly limited to infants and the elderly. Hypothermia is also common, however, in specialized sectors of the population which are routinely or accidentally exposed to cold environments during the normal course of their activities. One such group includes sport, military and commercial divers. In fact hypothermia remains a major limitation to divers in cold waters such as the coastal areas of North America and Europe, in the North Sea and in deep waters (greater than 180 metres) throughout the world. Diver hypothermia may be caused from normal exposure during prolonged dives, or as the result of accident, such as the case of a diver in a lost bell.

The primary cause of diver hypothermia is the rapid loss of body (core) heat into the surrounding water, either by direct transfer through the diving suit or by loss of heat to the diving gas. Water conducts heat approximately 25 times more rapidly than does air. The body's first reaction to being submerged in cold water is the vasoconstriction of the blood vessels in the skin which results in a net decrease in body heat lost to the water.

Heat loss can also be minimised by proper insulation, such as a diving suit or a layer of subcutaneous fat. In active situations, however, these latter measures do not maintain a balance between body heat produced and lost. Thus, the body produces more heat such as that produced by shivering. Increased heat production also results from increased activity, such as exercise or hard work.

Shivering and increased physical activity can, however, also lead to increased exposure of the body and even more heat loss. In addition, physical activity requires more oxygen, more rapid breathing and causes additional heat loss from the lungs to the diving gas. This is especially important at depths greater than 183 metres of sea water (MSW) since the denser gas can lead to appreciable heat loss.

For example, normal heat loss to air from the lungs is approximately 10% of the total body heat loss. Under hyperbaric heliox or trimex at 183 MSW or more, heat loss from the lungs to the breathing gas can approach the same order of heat loss from the body to the water. It is thus apparent that the human body, unaided, cannot offset hypothermia in cold waters for any appreciable time.

The onset of hypothermia in divers is dependent on a number of practical, environmental and physiological factors. In each case some, but not all, of these factors can be controlled. For example, factors such as the length of dive and the type of diving suit used can be optimized for the conditions at hand; but water temperature and the composition of the diving gas required cannot be altered significantly. The use of helium, for example, has allowed divers to achieve depths far in excess of those achieved with air; but, in return, the high thermal conductivity of helium dramatically increases heat loss from the diver into the breathing gas as noted above.

Physiological factors affecting diver hypothermia are more complex and include the degree of cold adaptation of the diver, his work activity during the dive, his physical makeup (such as amount of body fat), his metabolic response to cold stress and any pre-dive use of drugs. Such factors are variable from diver to diver, and thus would appear poor control points for hypothermia.

In many cases, however, physiological control of hypothermia may be partially successful or provide a basis for the design of new approaches toward offsetting hypothermia. For example, cold adaptation can help against mild hypothermia and may involve actual changes in metabolism. This is illustrated by the Japanese and Korean Ama (diving women) who have a basal metabolic rate approximately 30% greater in winter than that of nondiving women living in the same climate and eating the same diet. Studies on divers under saturation conditions have shown that their metabolic rates also increase if the temperature of their environment falls below 30°C.

Changes in metabolism or in the rate of nutrient absorption and metabolism may also account for the well-documented losses of weight in saturation chamber dives. For example, in experimental dives such as Helgoland, Tektite I and II, Sea Lab II, and Hana Kai II, the divers ate the equivalent of from 2500 to 6000 Kcal/day but still recorded total dive weight losses of from 0.6 to 4 kg, depending on the duration of the dive and depth.*

The apparent correlation of metabolic change with depth, and time at depth, becomes very intriguing when viewed as a detriment toward diver resistance to hypothermia. For example, it has been shown that under saturation conditions, essential metabolic levels of thiamine (vitamin B) and thiamin-dependent enzymes decrease in proportion to time at depth. Since thiamine requirements may be directly proportional to energy expenditures, saturation divers may experience physiological stresses which decrease efficient nutrient utilization and, thus, become more susceptible to hypothermia.

*By Ed. *SPUMS J.*

Recent work suggests that this weight loss is largely due to an increased water loss as urine. (Shiraki, K. Sagawa, S. Konda, N. Nakayama, H. and Matsuda, M. Hyperbaric diuresis at a thermoneutral 31 ATA HeO_2 environment. *Undersea Biomedical Reseach* 1984; 11: 4, 341-353).

It also has been suggested that divers may respond to the hyperbaric environment by gradually losing small amounts of heat (approximately 0.5 to 1.0 Kcal/min) to result in a long term body heat loss without apparent, gross change in metabolism or core temperature. This would then explain weight loss in saturation environments. This could also support the physiological stress theory advanced above and certainly decrease the diver's resistance to hypothermia should his temperature or his environment change rapidly.

There is reason to believe that the hyperbaric environment may act directly on those physiological processes controlling thermoregulation and thus potentiate diver hypothermia. For example, changes in thyroid and adrenal cortex hormone levels in the blood occur at depth and may indicate direct effects of pressure on central nervous system (CNS) control of body temperature. Such pressure effects on neurological processes are not unknown and are best illustrated by the pressure-induced high pressure nervous syndrome (HPNS). Studies conducted at Arthur D. Little, Inc. have shown that pressure can directly affect the molecular processes involved in neural transmission and, thus, thermoregulation.

It is interesting that many drugs are known to directly cause or potentiate hypothermia. For example, the active agents in marijuana, the tetranydrocannabinoid, are among the most potent hypotheria-inducing agents known and appear to cause this effect by decreasing oxygen consumption with a concurrent net decrease in heat production. It is also known that the effects of the tetranydrocannabinoid are potentiated and/or changed under hyperbaric pressure. Thus, a combination of pressure and a drug inducing hypotheria may make divers more susceptible to hypothermia.

Other drugs such as morphine, the tranquilizers reserpine and chlorpromazine and the stimulatory amphetamines are all known to cause hypothermia. Their action sites appear to be in the CNS, suggesting that future studies using such drugs as models could design new therapies to control hypothermia at a cellular or molecular level.

In the meantime, divers are to be warned of the high risk in using such drugs prior to diving. Divers should also minimize their use of alcohol prior to diving since alcohol will induce vasodilation and resulting heat loss.

Treatment of Diver Hypothermia

The classical and still practical method for the treatment of diver hypothermia relies on restoring the victim's temperature back to normal as quickly as possible. In the field, this therapy involves placing the diver in a warm bath with elevation of the head and limbs out of the water. For milder cases of hypothermia, hot showers may suffice. Warm drinks and the administration of (warmed) intravenous fluids can also be used, especially if fluid and electrolyte imbalances exist in the victim.

In some cases more drastic measures may be required if hospital facilities are immediately available such as inhalation of warm oxygen and the circulation of warm fluids through the body (haemodialysys, peritoneal lavage, intrathoracic irrigation). To date, no proven therapy exists for the treatment of hypothermia with drugs.

Thermoregulation Controls

Currently, there is no standard procedure to prevent and/or treat diver hypothermia by controlling the diver's physiology with one possible exception; the use of steroids or antihistamines to treat cold urticaria. Our interests are directed at such physiological prevention and control of hypothermia using nutritional and pharmacological approaches. This is exemplified in a new nutritional product now being developed based on studies utilizing this product as a drug delivery system. For example, it is known that the efficacy of certain drugs, such as griseofulvin and several steroids, are improved when given orally in fats rather than per se.

Based on this knowledge, Arthur D. Little, Inc. has developed a hydrolyzed lipid formulation, termed "lymphasomes" (patent pending) which dramatically improves the absorption and efficacy of a number of drugs, including the contraceptive, oestradiol and fat soluble vitamins such as the retinoids.

In the course of these studies, the ability of the lymphasomes to act as a rapidly absorbed and utilized energy source in the body tissues was investigated. For example, the metabolic rate of the lymphasomes in rats was followed using lymphasomes labelled with radioactive fatty acid. It was shown that within six hours, approximately 45 per cent of the lymphasome lipid had been matabolized to expired carbon dioxide. In actual fact, measurement of radioactive carbon dioxide only represents a minimum estimation of lipid utilization and does not account for use of the lipid metabolic products for other purposes which would not immediately release the tracer.

Thus these studies more realistically indicate that the lymphasome lipids are probably completely absorbed and metabolized within 12 to 24 hours, with the majority of utilization occurring 6 hours after administration. Parallel experiments showed that the delivery of lymphasome lipids into blood was a sustained process resulting in constant lipid blood levels starting at approximately 1 hour and lasting for at least 8 hours. Insignificant amounts of the lymphasome lipids were found in faeces, again indicating nearly complete absorption. These data supported earlier conclusions that the lymphasome high fat product is readily absorbed from the intestine into the lymphatic system and is then delivered by the blood to the tissues for immediate and sustained heat and energy production.

How can this lymphasome concept be applied to the problems associated with diver hypothermia? In order to answer this question, a discussion of some basic principles of fat absorption and utilization is needed and follow.

It is well documented that physically active, trained individuals (such as divers) oxidize more fat and less carbohydrate than any untrained individuals when carrying out comparable, submaximal work. In fact, regularly performed endurance exercise can increase the capacity for aerobic metabolism based on increased fat utilization with decreased carbohydrate consumption.

Questions have been raised, however, concerning the proper diet for supporting a rigorous work or activity schedule. In general, it is agreed that high protein, high fat diets should be avoided. Thus diets intended for use in high stress situations have tended to emphasize a high carbohydrate content such as, for example, a diet receiving 15 per cent of its calories from protein, 33 per cent from fat and 52 per cent from carbohydrate. However, such diets are based on the assumption that all the carbohydrate will be fully utilized to carbon dioxide and water.

TABLE 1

Yield of work-related energy and heat from carbohydrate and fat

Nutrient	Metabolic Products	Heat Generated (Kcal/g)	Work Potential* (Kcal/g)
Carbohydrate (glucose)			
Anaerobic Metabolism	Lactic Acid	-	0.2
Aerobic Metabolism	CO_2/H_2O	1.4	2.1
	Total	1.4	2.3
Fat			
(Palmitic Acid)	CO_2/H_2O	5.1	4.1

*Work potential represents production of high energy yielding adenosine triphosphate (ATP), which contains 11 Kcal of potential work per molecule.

As shown in Table 1, the metabolism of carbohydrate can be both anaerobic and aerobic. In stressful situations such as sustained hard work, anaerobic carbohydrate metabolism predominates. While such metabolism can provide the initial burst of energy for muscle during physical activity, it is insufficient to maintain energy requirements for sustained physical activity in a stressful situation such as that of a hard working diver. In contrast, aerobic fat metabolism does provide the sustained energy required under stressful conditions. In fact, mobilization of fat in the body has been shown to increase endurance by 50 per cent and to decrease the rate of glycogen depletion under stress conditions. On the other hand, prevention of hypoglycemia in humans does not delay exhaustion from sustained physical activity.

We thus propose that in high activity, stressful situations, a diet receiving 13 per cent of its calories from protein, 33 per cent from carbohydrate and 54 per cent from fat would be more effective. This diet is based on physiological estimates that for normal work output, a total caloric intake of 4368 Kcal per day is required: 1968 Kcal for basal metabolism and 2400 Kcal for work. Such work could be equivalent to, for example, six hours for a diver working at depth.

One problem concerning a high fat, high energy diet needs to be surmounted before it can be used in a cold-stress situation. Simply stated, fats are the slowest and most difficult of all nutrients to be absorbed in the intestinal tract. This is due to the requirement that fat must be first hydrolized before it is absorbed into the intestinal lymph and then into the blood. Such hydrolysis is dependent on two components which are normally secreted into the intestinal tract: pancreatic lipase and bile salts. Of these two, bile salts appear directly affected by stressful conditions including cold stress. Thus, under hypothermic conditions, bile salts secretion decreases significantly (approximately 5 to 7% per °C) and this decrease results in decreased fat hydrolysis and hence decreased fat absorption and utilization. In addition, the dehydration and accelerated loss of body fluids which occurs in stressful (including hyperbaric) situations also decreases fat hydrolysis and absorption.

TABLE 2

Estimates of carbohydrates, fat and protein required for providing 4368 Kcal in 24 hours

	High Carbohydrate Diet				High Fat Diet			
Nutrient	% Kcal	Kcal	Weight g	%	% Kcal	Kcal	Weight g	%
Carbohydrate (glucose)	52	2272	608	66	33	1441	385	49
Fat (palmitic acid)	33	1441	158	17	54	2358	258	33
Protein	15	655	160	17	13	569	139	18
Totals	100	4368	926	100	100	4368	782	100

Our proposed high fat diet is compared to the recommended high carbohydrate diet for stressful condition in Table 2. The primary difference between the diets is their yield of heat: the high fat diet yields approximately 500 Kcal more heat even though its total food weight is 15 per cent less than the high carbohydrate diet. The difference could be especially important to the working diver exposed to a cold environment.

For example, the initial stages of hypothermia include shivering, which can increase the requirement for body heat production as much as 500 Kcal/hour. This requirement or others for body heat can in turn lead to a rapid imbalance between body heat produced and lost, and potentiate the onset of more serious hypothermia. Thus, a high fat diet could significantly aid in offsetting this condition.

A paradoxical situation thus exists concerning proper utilization of nutrients under stressful conditions. While fats are a superior source of rapid heat and energy, the very condition itself decreases fat utilization. The lymphasome concept for fat absorption specifically addresses this impasse. The lymphasomes do not require hydrolysis in the intestinal tract since that process has already been carried out prior to ingestion. In the intestinal tract the lymphasomes are rapidly absorbed and utilized by muscle for heat and energy production. In addition, the product is stable to storage and could be provided in a food bar form.

The lymphasomes (high fat) diet would be utilized by sport, commercial and military divers during routine dives in cold waters. It would provide not only additional work potential for the diver at depth, but would also provide heat for both the diver's comfort and to aid in offsetting hypothermia. The lymphasomes could also be used as an emergency ration, e.g. in lost bell situations and for the treatment of hypothermia.

Future exploitation of the lymphasomes might include the use of their drug delivery properties to administer specific metabolic stimulants to fat metabolism, or drugs which can control thermoregulatory responses. The lymphasome concept thus represents control of hypothermia by stimulating normal physiological functions. Such an approach is particularly relevant to the problems associated with diver hypothermia.

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The address of SEA TECHNOLOGY is Suite 1000, 1117 North 19th Street, Arlington, Virginia 22209, U.S.A.

HEAT LOSS AND THE WET SUIT

A recent study of Korean women divers at Korea's Kosin Medical College has useful implications for any cold water diver.

The researchers found that wet suits provide "unexpectedly high insulation" when worn by resting divers in water as cold as 15°C, but as soon as the divers undertook mild exercise the insulation value quickly dissipated.

The lesson? If a diver clad in a wet suit needs rescue and cannot escape from cold water he should remain still rather than swim, and so avoid heat loss and slow down the development of hypothermia.

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HEAT LOSS AND DIET

In a study performed by the medical faculty at the Institute of Physiology in Buenos Aires, Argentine, the reaction to immersion in 72°F water was studied in ten healthy male volunteers who ingested a balanced diet for three weeks (then were tested), followed by successive testing after three week diets of high carbohydrate, high protein, and high fat. Caloric intake was maintained from diet to diet.

The researchers concluded that the "reaction to cold water immersion was demonstrable for all groups, but more efficient in subjects who had received either balanced or high carbohydrate diets", suggesting that high protein or high fat diets reduce cold adaptation. But one has to wonder. Would an Eskimo agree?

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LESSENING THE RISK OF DECOMPRESSION SICKNESS

John Lippmann

ADDING SAFETY TO THE U.S. NAVY TABLES

Many divers have devised methods to add some degree of extra safety to their U.S. Navy (USN) Table calculations. Some methods are obviously better than others. I have chosen some methods that I know of to present in the following section. These methods should provide quite a lot of extra safety, but still cannot be guaranteed to prevent decompression sickness.

I believe that sport divers are better off using a more appropriate set of tables At present I know of two tables, which are based on the U.S. Navy system, which I think should be used instead of the USN tables for sport diving purposes. They are the "Huggins Tables" and the "Bassett Tables". There are also tables, based on other systems, that may be more suitable than the U.S. Navy Tables. These are the DCIEM and Buehlmann Tables.

<u>Methods for making no-decompression dives safer</u>

A Choose an initial no decompression limit (NDL) by choosing the NDL for the next greater table depth. For example the NDL for a dive to 21 m is 50 minutes. To add safety for this dive take the NDL for 24 m (40 minutes) as your initial NDL. For a dive to 31 m look up the NDL for 36 m rather than the NDL for 33 m. So the initial NDL for this dive is 15 minutes (rather than 20 minutes).

This procedure converts the USN limits into limits which are often very similar to those of Bassett and Huggins.

B Reduce this initial NDL further for any decompression sickness predisposing factor(s). For a dive to 21 m the initial NDL is 40 minutes. If I expect to get cold I will reduce this time by at least 4 minutes (10% reduction). If I am 7 kg overweight I will take off another 10% (4 minutes). Now my actual no-decompression bottom time becomes 40-4-4 = 34 minutes.

This limit is now quite similar to the DCIEM and Swiss limits.

C Ascend at about 10 m/minute.

D Stop at between 3 and 6 m for 3-5 minutes before surfacing.

E Use the total dive time (total time underwater) for the actual dive done to find the repetitive group (RG) after the dive.

Example 1.

You are planning to do two no-decompression dives, the first to 20 m followed 3 hours later by a dive to 16 m. Using the suggested safety factors, find the allowable no-decompression bottom time. Assume that there are no predisposing factors for decompression sickness present. Before you go any further get your copy of the USN tables and see if you get the right answers.

1 As 20 m is between 18 and 21 m look up the NDL for 24 m (ie. next greater depth increment). This limit is 40 minutes which is the maximum allowable bottom time for the proposed dive.
2 Ascend at 10 m per minute.
3 Do a safety stop at 3-6 m for say 3 minutes.
4 Total dive time = 40 (bottom time) + 3 (stop time) + 2 (ascent time) = 45 minutes.
5 To find the repetitive group after the dive look up 21 m (the actual dive) for 45 minutes (total dive time) which gives group I.
6 Repetitive group after a surface interval of 3 hours is D.
7 The proposed depth of the second dive is 16 m. The residual nitrogen time (RNT) for group D for a dive to 16 m (more than15 m and less than 18 m) is 24 minutes.
8 The proposed depth of the second dive is 16 m so look up the NDL for 21 m (ie. next greater depth increment) which is 50 minutes.
9 Allowable bottom time is 50 (NDL) - 24 (RNT) = 26 minutes.
10 Leave the bottom after 26 minutes.
11 Ascend at 10 m per minute.
12 Stop at 3-6 m for 3-5 minutes.

The unmodified USN times for the two dives would be 50 minutes and 30 minutes.

Example 2.

You are planning to do two no-decompression dives, the first to 33 m followed 5 hours later by a dive to 30 m. Using the suggested safety factors, find the allowable no-decompression bottom time. Again assume that there are no predisposing factors for decompression sickness present.

1 Look up NDL for 36 m (the next greater depth increment). The limit is 15 minutes, which is the maximum allowable bottom time for this dive.
2 Ascend at 10 m per minute.
3 Do a safety stop at 3 to 6 m for 5 minutes.
4 Total dive time = 15 (bottom time) + 5 (stop time) + 3.3 (ascent time) = 24 minutes (rounded to next minute above.)
5 To find the repetitive group after the dive look up the actual dive of 33 m for 24 minutes, as this is outside the NDL for 33m (20 minutes) look in the full U.S. Navy decompression table, which gives group H
6 Repetitive group after a surface interval of 5 hours is B.
7 The proposed depth of the second dive is 30 m. The residual nitrogen time in group B for 30 m is 7 minutes.
8 The proposed depth of the second dive is 30 m so look up NDL for 33 m (ie. next greater depth increment)which is 20 minutes.
9 Allowable bottom time = 20 (NDL) - 7 (RNT) = 13 minutes
10 Leave the bottom after 13 minutes.
11 Ascend at 10 m per minute.
12 Stop at 3 to 6 m for 5 minutes.

The unmodified USN times for these dives would be 20 minutes and 18 minutes.

F Another method which is often suggested is to first reduce the USN NDL by 10% for each predisposing factor present. Then ensure that you leave the bottom with sufficient time left to ascend at 10 m per minutes and to reach the surface before this reduced NDL expires.

I believe that this method is often not conservative enough and that the previous method, although more complicated, should be used in preference to this method. For example, for a single dive to 18 m method F allows a maximum (ie. not allowing for predisposing factors) no-decompression bottom time of 58 minutes. This 58 minutes is significantly longer than the times suggested by the Swiss, Canadian, Huggins and Bassett Tables.

<u>Methods for making decompression dives safer</u>

A Choose the decompression schedule by adding one depth increment and one bottom time increment to the schedule for the dive you wish to do. For example for a dive to 17 m for a bottom time of 65 minutes use the schedule for 21 m for 80 minutes.

B Reduce your ascent rate to 10 m per minute.

C Select your RG according to the decompression done, if you decompressed as for 21 m for 80 minutes for a dive to 17 m for 65 minutes, your RG is M.

D If you get cold or work hard during the dive then you should increase your decompression time by adding another bottom time increment. This would mean for the previous dive decompressing as for a dive to 21 m for 90 minutes. This will often give decompression well in excess of other tables but, if air is available and the conditions are right, it is a cheap insurance!

Example 1.

You are planning a decompression dive to 27 m for a bottom time of 38 minutes. What decompression schedule should you use?

1 Select the schedule for the next greater tabled depth increment which will be 30 m and for the next longer time increment which will be 50 minutes. This requires stops of 2 minutes at 6 m and 24 minutes at 3 m.
2 Ascend at 10 m per minute.
3 The RG after the dive will be L.

Example 2.

You are planning a decompression to 36 m for a bottom time of 20 minutes. The water is cold and you expect to work hard during the dive. What decompression schedule should you select?

1 Initially add one depth and one time increment. This gives 39 m for 25 minutes.
2 Then add another bottom time increment to cater for the cold and exercise. This gives 39 m for 30 minutes. The decompression required is a stop at 6 m for 3 minutes followed by a stop at 3 m for 18 minutes.
3 The RG after the dive is M.

SAFER ALTERNATIVES BASED ON THE U.S. NAVY TABLES

The Huggins Tables

In 1976 Dr Merril Spencer published a report in which he stated that he had found that divers who were exposed to some of the U.S. Navy no-decompression limits, developed high counts of "silent bubbles" (venous gas emboli) during and after ascent from depth. The bubbles were detected using a Doppler Ultrasonic Bubble Detector. He believed that the bubbles resulted from the release of excess nitrogen in the divers' bodies. On the basis of this work, Spencer recommended new no-decompression limits (NDLs), which were calculated in an attempt to prevent bubble formation after a dive. These limits are shown in Table 1. Subsequent studies carried out by Dr Andrew Pilmanis and Dr Bruce Bassett confirmed Spencer's findings.

TABLE 1

NO-DECOMPRESSION LIMITS, IN MINUTES, OF THE USN, SPENCER AND BASSETT TABLES

Depth m	Depth ft	U.S. Navy	Spencer	Bassett
9	30	-	225	220
10.5	35	310	165	180
12	40	200	135	120
15	50	100	75	70
18	60	60	50	50
21	70	50	40	40
24	80	40	30	30
27	90	30	25	25
30	100	25	20	20
33	110	20	15	15
36	120	15	10	12
39	130	10	5	5

These findings confirmed a growing concern in the sport diving community that the U.S. Navy No-Decompression Limits are not as safe for the sport diver as they should be. As a result, in 1981, Karl Huggins generated a new set of no-decompression tables which are based on Spencer's recommendations. These new no-decompression tables published by the Michigan Sea Grant College Program became known as the "Huggins Tables". They are designed in an attempt to prevent the formation of bubbles, asymptomatic or otherwise.

The Huggins Tables are based on the same concepts and format as the U.S. Navy Tables. Using the same six theoretical tissue groups as the Navy tables, with half-times of 5, 10, 20, 40, 80 and 120 minutes, Huggins determined the new, lower critical nitrogen levels (M values) corresponding to the shortened NDLs recommended by Spencer. Huggins also determined new Repetitive Group Designators which represent the nitrogen levels in all six tissue groups, rather than just in the 120 minute tissue as in the USN tables. This makes these tables far more suitable for multi-level diving.

These tables have not been officially tested, but are more conservative than the U.S. Navy Tables when used to find the limits for single and repetitive no-decompression dives.

They consist of a Repetitive Group Table, a Surface Interval Table and a Residual Nitrogen Table and are reproduced on page 73.

THE HUGGINS TABLES reproduced with acknowledgements to the Michigan Sea Grant College Program.

SURFACE INTERVAL TABLE

NEW GROUP	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A	12:00 0:10	12:00 2:31	12:00 3:42	12:00 4:43	12:00 5:23	12:00 5:57	12:00 6:21	12:00 6:49	12:00 7:09	12:00 7:30	12:00 7:46	12:00 8:01	12:00 8:18	12:00 8:27
B		2:30 0:10	3:41 1:20	4:42 2:21	5:22 3:01	5:56 3:35	6:20 3:59	6:48 4:27	7:08 4:47	7:29 5:08	7:45 5:24	8:00 5:39	8:17 5:56	8:26 6:05
C			1:19 0:10	2:20 1:04	3:00 1:44	3:34 2:18	3:58 2:42	4:26 3:10	4:46 3:30	5:07 3:51	5:23 4:07	5:38 4:22	5:55 4:39	6:04 4:48
D				1:03 0:10	1:43 0:50	2:17 1:24	2:41 1:48	3:09 2:16	3:29 2:36	3:50 2:57	4:06 3:13	4:21 3:28	4:38 3:45	4:47 3:54
E					0:49 0:10	1:23 0:43	1:47 1:07	2:15 1:35	2:35 1:55	2:56 2:16	3:12 2:32	3:27 2:47	3:44 3:04	3:53 3:13
F						0:42 0:10	1:06 0:34	1:34 1:02	1:54 1:22	2:15 1:43	2:31 1:59	2:46 2:14	3:03 2:31	3:12 2:40
G							0:33 0:10	1:01 0:34	1:21 0:54	1:42 1:15	1:58 1:31	2:13 1:46	2:30 2:03	2:39 2:12
H								0:33 0:10	0:53 0:30	1:14 0:51	1:30 1:07	1:45 1:22	2:02 1:39	2:11 1:48
I									0:29 0:10	0:50 0:29	1:06 0:45	1:21 1:01	1:38 1:17	1:47 1:26
J										0:28 0:10	0:44 0:26	1:00 0:42	1:16 0:58	1:25 1:07
K											0:25 0:10	0:41 0:24	0:57 0:40	1:06 0:49
L												0:23 0:10	0:39 0:24	0:48 0:33
M													0:23 0:10	0:32 0:18
N														0:17 0:10

NEW GROUP	20	30	35	40	50	60	70	80	90	100	110	120	130
A	12	8	7	6	5	4	4	3	3	3	3	2	2
B	28	18	16	14	11	9	8	7	6	6	5	5	4
C	45	29	25	21	17	14	12	9	8	6	6	5	5
D	65	41	34	30	23	19	15	10	8	7	6	5	5
E	86	53	44	37	28	22	17	12	9	8	7	6	5
F	111	66	53	43	32	24	19	14	11	9	7	6	6
G	140	80	62	49	36	27	22	17	12	10	8	7	6
H	175	96	73	57	40	30	24	19	14	11	9	8	7
I	219	113	86	65	45	34	26	21	16	12	10	8	7
J	279	132	103	75	51	38	29	23	18	13	11	9	8
K	369	154	122	88	57	43	32	26	20	15	12	10	8
L	-	178	139	103	64	47	35	28	22	18	13	11	9
M	-	207	158	124	71	52	40	30	25	20	15	12	10
N	-	225	165	135	75	53	41	31	26	21	16	13	11

DEPTH

DEPTH (FT.)	NO DECOM. LIMITS	BOTTOM TIME AND REPETITIVE GROUP CODE													
		A	B	C	D	E	F	G	H	I	J	K	L	M	N
20	-	10	25	40	60	85	110	135	170	215	275	325			
30	225	5	15	25	40	50	65	75	95	110	130	150	175	205	225
35	165	5	15	20	30	40	50	60	70	85	100	120	135	155	165
40	135	5	10	20	25	35	40	45	55	60	70	85	100	120	135
50	75	-	10	15	20	25	30	35	37	40	50	55	60	70	75
60	50	-	5	10	15	20	23	25	27	30	35	40	45	47	50
70	40	-	5	10	13	15	17	20	23	25	27	30	33	35	40
80	30	-	5	7	→	10	13	15	17	20	→	25	27	→	30
90	25	-	-	5	7	→	10	→	13	15	17	→	20	23	25
100	20	-	-	-	5	7	→	→	10	→	→	13	15	17	20
110	15	-	-	-	-	5	→	7	→	→	10	→	→	13	15
120	10	-	-	-	-	-	5	→	→	7	→	→	10		
130	5	-	-	-	-	-	5								

* NEW *

NO-DECOMPRESSION TABLES

Michigan Sea Grant College Program

The University of Michigan • Michigan State University

The Bassett Tables

Dr Bruce Bassett, a physiologist, was commissioned by the U.S. Air Force to validate some schedules for flying after diving. He had to construct a set of tables which would allow a diver to be flown to an altitude of 3,000 metres immediately after surfacing from a dive.

Using the mathematics of the U.S. Navy tables, Bassett calculated a set of equivalent no-decompression dives, after which a diver would not reach the critical nitrogen levels (maximum supersaturation ratios) of the U.S. Navy table, until reaching 3,000 m. Bassett placed "divers" in a chamber for various periods of time before "surfacing" them, and then reducing the pressure to its equivalent at 3,000 m. The divers did not do an 18 m for 60 minutes dive. Instead they spent 20 minutes at 18 m and then ascended to 3,000 metres. Bassett believed that the calculated nitrogen pressures in the theoretical half-time tissues on reaching 3,000 metres were identical to that of surfacing after an 18 m for 60 minutes dive.

If the U.S. Navy tables were safe, these shorter dives followed by decompression to altitude should have been safe. They were not, as Bassett's divers had a bends incidence of about 6%, and silent bubbles were detected in about 30% of the divers. This was unacceptable. Bassett's results were similar to those of Dr Merril Spencer in Seattle, who had tested the U.S. Navy NDLs in a chamber, and found a comparable bends incidence and silent bubble count.

These two sets of dry chamber data and the knowledge that the U.S. Navy divers always added depth and time increments before calculating decompression, led Dr Bassett to re-calculate his dive schedule using lesser maximum nitrogen values (M values). That is, he reduced the allowable supersaturation in the various half-time tissues and so got shorter NDLs. When Bassett tested his revised decompression procedures in the chamber there were no bends.

Bassett issued a new set of No-Decompression Limits which are more conservative, and which he believed are far more appropriate for sport diving, than the U.S. Navy NDLs. Bassett also recommended that "all dives greater than 30 ft (9 m) end with 3-5 minutes at 10-15 ft (3-5 m)". He also suggested that the total time underwater be used (rather than just bottom time) to determine the repetitive group after a dive.

Alarmed by the increasing incidence of decompression sickness in Australia, John Knight and John Lippmann, seeking to encourage the use of Bassett's limits, created a repetitive dive table which John Knight eventually published. The table, shown on page 75, incorporates Bassett's limits, his recommendations and other safe diving practices designed to reduce the risk of decompression sickness. They are available commercially in Australia and fit easily into the pocket of a buoyancy compensator.

These tables have not been officially tested, but are more conservative than the U.S. Navy Tables when used to find the limits for single and repetitive no-decompression dives.

Features of the table are:

1 An ascent rate of 10 m/minute is recommended, as slow ascents seem to produce fewer cases of decompression sickness. Bassett's limits were calculated on an ascent rate rate of 18 m/minute so this slower ascent is not essential but should provide extra safety.

2 A safety stop of 3-5 minutes at 3-5 m is recommended after all dives deeper than 9 m whenever possible.

3 The total time underwater, rather than just the bottom time, is used to calculate the repetitive group after a dive.

4 (a) The Bassett NDLs are given in the third column of Table 1. The rest of Table 1 is for finding the repetitive group (using the total time underwater) at the end of the dive.

(b) Table 2 is a slightly abbreviated form of the U.S. Navy Surface Interval Table.

(c) To calculate the allowable bottom times for repetitive dives, Table 3, John Knight simply subtracted the U.S. Navy Residual Nitrogen Times from the Bassett limits rather than from the U.S. Navy NDLs as is normally done.

5 A decompression table is provided as a back-up should the need arise. The decompression table provided is to cater for the situation where a diver accidently overstays his no-decompression time. The times in this table (Table 4 on page 75) are those from the U.S. Navy table with an extra 5 minutes added to the 3 m stop. It is certainly not a recommended decompression table to be used for decompression diving but should be more than adequate to cover a diver in the situtión described.

6 The system allows two dives without any calculations. For a third dive deeper than 9 m one does a similar calculation to that with the U.S. Navy tables. For third or subsequent dives to 9 m or less no further calculation is required; one can dive to the 9 m NDL of 220 minutes.

Example 1.

What is the maximum allowable bottom time for a single or first no-decompression dive to 20 m?

1 Enter Table 1 from the left at the exact, or next deeper depth. In this case enter at 21 m. Move right to column 3 (Bassett Bottom Time Limits) to find the allowable bottom time. It is 40 minutes. This means that you must leave the bottom after a maximum of 40 minutes, ascend at about 10 m/minute and stop at 3-5 m for say 3 minutes

READ THIS BEFORE USING THE TABLES

1. Bottom time starts on leaving the surface and stops on starting the ascent.
2. Use the deepest depth of the dive as the depth of the dive for calculation.
3. If the deepest depth of the dive is between two depths in the table use the greater depth for calculations.
4. If the time is between two times in the table use the longer time for calculations.
5. After a dive calculate the repetitive group.
6. After the surface interval calculate the new repetitive group.
7. Using the planned depth of the next dive enter the repetitive dive table to find the no-decompression bottom time available for that repetitive group and depth.

ASCENT RATE 10m A MINUTE.

ON ALL DIVES DEEPER THAN 9m (30ft) DO A 3-5 MINUTE SAFETY STOP AT 3-5 M.

USE THE TOTAL TIME UNDERWATER (BOTTOM TIME + ASCENT TIME + SAFETY STOP TIME) TO FIND THE REPETITIVE GROUP AT THE END OF THE DIVE.

TABLE 4

MODIFIED AIR DECOMPRESSION TABLE*

Depth m	Depth feet	Bottom Time minutes	Decompression Stops minutes at 10 feet	Repetitive group
18	60	70	7	K
		80	12	L
21	70	60	13	K
		70	19	L
24	80	50	15	K
		60	22	L
27	90	40	12	J
		50	23	L
30	100	30	8	I
		40	20	K
33	110	25	8	H
		30	12	J
36	120	20	7	H
		25	11	I
39	130	15	6	F
		20	10	H
42	140	15	7	G
		20	11	I
45	150	5	5	C
		10	6	E

* FOR THOSE WHO ACCIDENTALLY EXCEED THE NO-DECOMPRESSION LIMITS

TO CALCULATE THE REPETITIVE GROUP AFTER A REPETITIVE DIVE.

3rd DIVES BELOW 9m(30 feet) ARE NOT RECOMMENDED.
A REPETITIVE DIVE IS ANY DIVE WITHIN 12 HOURS OF THE LAST DIVE.

1. Subtract the actual bottom time of the repetitive dive from the bottom time available in table 3 to get an answer in minutes.
2. Subtract this time difference from the Bassett Bottom Time limits in table 1. The answer is the equivalent bottom time of the repetitive dive.
3. Add the ascent time and the safety stop time to the answer in 2. This is the equivalent total time underwater of the repetitive dive.
4. Use this time to enter table 1 to find the repetitive group at the end of the dive.

A 2B PENCIL WRITES WELL ON THIS PLASTIC AND IS EASILY RUBBED OUT.

	EXAMPLE	2nd dive	3rd dive*
Repetitive Group before the dive.	B		
Proposed depth of dive	24 m		
Bottom time available	22 min	min	min
- Actual bottom time	20 min	min	min
= Difference	2 min	min	min
Bassett Bottom Time limit	30 min	min	min
- Difference	2 min	min	min
= Equivalent Bottom Time	28 min	min	min
+ Ascent time	3 min	min	min
+ Safety stop time	5 min	+ 5 min	+ 5 min
= Equivalent total time underwater	36 min	min	min
Repetitive group at the end of the dive	I		

The RESIDUAL NITROGEN TIME can be found by subtracting the MAXIMUM TIME AVAILABLE FOR A REPETITIVE DIVE (Table 3) from the BASSETT BOTTOM TIME LIMITS (column 3 of table 1).

DR BRUCE BASSETT'S REVISED BOTTOM TIMES "NO DECOMPRESSION" DIVE TABLE

ARRANGED FOR REPETITIVE DIVES BY JOHN KNIGHT & JOHN LIPPMANN

BEFORE USING THIS TABLE READ THE OTHER SIDE.

ACENT RATE 10m A MINUTE

ON ALL DIVES DEEPER THAN 9m (30ft) DO A 3-5 MINUTE SAFETY STOP AT 3-5m.
USE THE TOTAL TIME UNDERWATER (BOTTOM TIME + ASCENT TIME + SAFETY STOP TIME) TO FIND THE REPETITIVE GROUP AT THE END OF THE DIVE.

The times in *italics* in the table are OUTSIDE the Bassett Bottom Time limits but are included for ease of calculating the repetitive group using the TOTAL TIME UNDERWATER.

TABLE 1.

Depth M	Depth feet	Bassett Bottom Time Limits	Time Underwater											
9	30	220	15	30	45	60	75	95	120	145	170	205	*250*	*310*
10	35	180	5	15	25	40	50	60	80	100	120	140	160	*190*
12	40	120	5	15	25	30	40	50	70	80	100	110	*130*	*150*
15	50	70		10	15	25	30	40	50	60	70	*80*	*90*	*100*
18	60	50		10	15	20	25	30	40	50	*55*	*60*		
21	70	40		5	10	15	20	30	35	40	*45*	*50*		
24	80	30		5	10	15	20	25	30	*35*	*40*			
27	90	25		5	10	12	15	20	25	*30*		*40*		
30	100	20		5	7	10	15	20	*22*	*25*	*30*			
33	110	15			5	10	13	15	*20*	*25*				
36	120	12			5	10	12	*15*		*20*	*25*			
39	130	10			5	8	10	*15*		*20*				
42	140	5			5	7	*10*		*15*					
Repetitive group at the end of the dive			A	B	C	D	E	F	G	H	I	J	K	L

ABBREVIATED U.S.N. SURFACE INTERVAL TABLE

Enter the table from the top using the appropriate repetitive group. Move across to the left until the appropriate interval is found then move down the column and out of the table into the REPETITIVE DIVE TABLE (Table 3)

TABLE 2

A	0:10 12:00											
B	2:11 12:00	0:10 2:10										
C	2:50 12:00	1:40 2:49	0:10 1:39									
D	5:49 12:00	2:39 5:48	1:10 2:38	0:10 1:09								
E	6:33 12:00	3:23 6:32	1:58 3:22	0:55 1:57	0:10 0:54							
F	7:06 12:00	3:58 7:05	2:29 3:57	1:30 2:28	0:46 1:29	0:10 0:45						
G	7:36 12:00	4:26 7:35	2:59 4:25	2:00 2:58	1:16 1:59	0:41 1:15	0:10 0:40					
H	8:00 12:00	4:50 7:59	3:21 4:49	2:24 3:20	1:42 2:23	1:07 1:41	0:37 1:06	0:10 0:36				
I	8:22 12:00	5:13 8:21	3:44 5:12	2:45 3:43	2:03 2:44	1:30 2:02	1:00 1:29	0:34 0:59	0:10 0:33			
J	8:41 12:00	5:41 8:40	4:03 5:40	3:05 4:02	2:21 3:04	1:48 2:20	1:20 1:47	0:55 1:19	0:32 0:54	0:10 0:31		
K	8:59 12:00	5:49 8:58	4:20 5:48	3:22 4:19	2:39 3:21	2:04 2:38	1:36 2:03	1:12 1:35	0:50 1:11	0:29 0:49	0:10 0:28	
L	9:13 12:00	6:03 9:12	4:36 6:02	3:37 4:35	2:54 3:36	2:20 2:53	1:50 2:19	1:26 1:49	1:05 1:25	0:46 1:04	0:27 0:45	0:10 0:26
	A	B	C	D	E	F	G	H	I	J	K	L

TABLE 3

MAXIMUM BOTTOM TIME AVAILABLE FOR A REPETITIVE DIVE

Depth M	Depth feet	A	B	C	D	E	F	G	H	I	J	K
9	30	213	203	195	183	171	159	147	133	119	104	82
12	40	113	103	95	83	71	59	47	33	19	4	
15	50	64	57	49	41	32	23	14	4			
18	60	45	39	33	26	20	14	6				
21	70	36	31	25	20	14	9	3				
24	80	26	22	17	12	7	2					
27	90	22	18	14	9	5	1					
30	100	17	13	10	6	2						
33	110	12	9	5	2							
36	120	9	6	3								
39	130	7	4	2								
42	140	3										

Each of these times takes the diver to the equivalent of the Bassett Bottom Time limits for that depth. If these times are accidentally exceeded, add the excess time to the Bottom Time Limit for that depth in Table 1, then use Table 4 to decompress.

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before surfacing.

2 To find the RG after the dive you must use the total dive time of 40 (Bottom time) + 2 (approximate. ascent time) + 3 (stop time) = 45 minutes. Move to the right across the 21 m row of Table 1 until finding the exact or next greater tabled total dive time, then move down the column to get the RG. In this case 45 minutes is tabled and moving down the 45 minute column gives a RG of I.

Example 2.

You have dived to 18 m for a bottom time of 40 minutes. You ascended slowly and did a safety stop en-route to the surface. After a 2 hour surface interval you wish to dive to 15 m. What is the maximum allowable bottom time for the 15 m dive?

1 For the first dive the NDL was 50 minutes, so you could have had a maximum bottom time of 50 minutes if required. You have spent 40 minutes bottom time, ascended slowly and done a safety stop, so the total time underwater should have been about 45 minutes. To find the RG after the first dive enter Table 1 at the row for 18 m, move right to find 45 minutes, which is not in the table, so in this case take 50 minutes, and move down to find the RG at the end of the dive. It is group H.

2 To find the new RG after the surface interval continue downwards to H on Table 2. Move across the H row, to the left, until finding the times which incude 2 hours, in this case 1:42-2:23. Move down this new column to find the group at the end of the surface interval which is Group E.

3 To find the maximum allowable no-decompression bottom time for the repetitive dive continue down the E column until intersecting the row corresponding to 15 m. You find the figure 32. This means that you can have a bottom time of 32 minutes at 15 m before ascending slowly, doing a safety stop and surfacing. Your total time underwater would be about 37 minutes.

4 Note that the maximum allowable bottom time for the second dive brings you to the Bassett single dive NDL for that depth (found in column 3 of Table 1). That is 32 minutes at 15 m for this repetitive dive is equivalent to 70 minutes (the Bassett limit for a single 15 m dive taken from Table 1) at 15 m for a first dive. The difference between the 70 minutes and the 32 minutes is the time already considered spent at 15 m before the second dive begins (Residual Nitrogen Time).

Example 3.

Three hours after the second dive in Example 2 you wish to dive to 12 m. What is the maximum allowable no-decompression bottom time for the dive?

1 You must first find the RG after the last dive. This dive was equivalent to a single dive to 15 m for a bottom time of 70 minutes. Adding the ascent and safety stop time of about 5 minutes, the equivalent total time underwater is 70 + 5 = 75 minutes. Now enter Table 1 from the left at 15 m and move across to the right to find the "equivalent time underwater" of 75 minutes. As this is more than 70 minutes take 80 minutes and move down the column, you get a RG of J.

2 Enter Table 2 from the right at J and find the surface interval of 3 hours. It lies between 2:21-3:04. Move down this column to get the RG after the surface interval, which is E.

3 Continue down into Table 3 until intersecting the row corresponding to the depth of the next dive (12 m). The number 71 is the allowable bottom time, in minutes, for this third dive.

Example 4.

During the last dive, after spending only 50 minutes of the allowable bottom time of 71 minutes at 12 m, you ascend slowly and stop for 3 minutes at 5 m. What is your RG after the dive?

1 Your 50-minute bottom time was 21 minutes shorter than the 70-minute limit for this repetitive dive. This repetitive dive of 50-minute is equivalent to a single 12 m dive of 120 - 21 = 99 minutes (i.e. 21 min. shorter than the single dive NDL of 120 minutes). Your equivalent time underwater is approximately 99 + 1 + 3 = 103 minutes.

2 To find your RG after the dive enter Table 1 at 12 m and move to the right until finding the time underwater of 103 minutes. Taking 110 minutes and moving down you get an RG of J.

Example 5.

Before a repetitive dive your RG is A. You had planned to dive to 30 m for 17 minutes as allowed, but after 15 minutes you notice that you have to 33 m. A glance at Table 3 shows that you were only allowed 12 minutes at this depth, so you have overstayed the 33 m limit by 3 minutes. What decompression is necessary?

1 This repetitive dive of 12 minutes at 33 m is equivalent to a single dive of 15 + 3 = 18 minutes (i.e. 3 minutes longer than the NDL for 33 m).
2 Turn to Table 4 and enter from the left at 33 m. Moving right the decompression is found to be 8 minutes at 3 m and the RG after the dive is I.

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John Lippmann is a FAUI instructor and the author, with Stan Bugg, of THE DIVING EMERGENCY HANDBOOK. His address is 24 Frogmore Road, Murrumbeena, Victoria 3163, Australia.

CROCODILE ATTACK FILE

Carl Edmonds

Following the successful reintroduction of the International Shark Attack File by both John West and myself, I have decided to extend the data collection to crocodile attacks, in Australia and surrounding islands.

We need to obtain the maximum documentation of the attacks from crocodiles in the Australian region, together with a rough estimate of the incidence of these attacks and the relationship to the crocodile numbers and conservation techniques. The Crocodile Attack File will intially rely on information given by knowlegeable observers, and by the follow up of newspaper reports.

If there are any SPUMS members who have any information on crocodile attacks or the victim, at any stage in Australia's history, would they be kind enough to relay this to me.

Specifically I would appreciate any information such as the name of the victim, location and the approximate date of the attack.

Because some SPUMS members have specialisations such as pathology and surgery, the information they have may be far more detailed than the above, and this extra information would be especially appreciated.

Many other SPUMS members live in coastal towns far from the larger teachng hospitals and it is possible that they are aware of crocodile attacks that may not have been reported elsewhere. Other people in your area may well be knowledgeable on this subject. Such people as the religious missions, who have looked after Aboriginal groups, are often a source of data which is not obtained elsewhere. Other physicians and naturalists are also a source of such inforation.

This project, the Crocodile Attack File, is likely to take a number of years to compile adequately before a full report can be issued. As usual, all contributions will be acknowledged, as in the case of the Shark Attack File and other Marine Animal Injury texts.

Unfortunately I have not been able to obtain any funding or research grants for this work, and therefore reimbursement has to be limited to reproduction of pages, photographs, etc. As always, once the work has been completed, all government and private organisations will expect (and unfortunately receive) the information which we supply and collect, in a charitable manner.

Thank you for any assistance that you may give in this regard. I am particularly interested in any information of the attacks prior to 1980.

Dr Carl Edmonds' address for correspondence is
Diving Medical Centre,
66 Pacific Highway,
St Leonards,
New South Wales 2065,
Australia.

HYPERBARIC FACILITY FOR WESTERN AUSTRALIA

Tenders have been called for the construction of a clinical hyperbaric facility at Fremantle Hospital. Six tenders were received and are currently being evaluated. It is hoped that the facility will be ready by the end of 1988.

The plans for the complex include a vertical cylinder with an internal diameter of 3.3 m which will have a 3 ATA capability. This will be used mostly for hyperbaric oxygen therapy. There will also be a fairly standard deck decompression chamber with a 6 ATA capability which will be available for the treatment of diving accidents requiring higher pressures.

The two will be joined by a common entrance lock which will allow either chamber to be maintained under pressure while attendants and medical staff can move in and out through the entrance lock.

Recently two Advanced First Aid Courses for Dive Supervisors (professional divers) have been held at Fremantle Hospital for Dive Supervisors requiring this qualifcation under recent legislation. It is planned to run courses on a more regular basis when the hyperbaric facility is in place.

We are grateful to Dr Harry Oxer of Fremantle Hospital for the above information.

HELP NEEDED

Dr Nick Cooper has requested help from those SPUMS members who attended the 1985 Annual Scientific Meeting at Bandos in the Maldives.

He writes "There is on Thursday Island a gravestone dedicated to a RAMC Captain who died as a result of stingray poisoning during the First World War. I saw it when I visited T.I.in 1977 and someone showed a slide of it during the 1985 AGM at Bandos. I cannot locate it. Once I have the name, or better still, a photo of the gravestone of the unfortunate officer, the archives in London could trace his records."

If anyone can flash some light on this gravestone please write to

Major N.Cooper RAMC,
BHM Rinteln,
BFPO 29,
3260 RINTELN,
WEST GERMANY.

ABSTRACTS OF INTEREST FROM THE 1987 JOINT CONFERENCE UNDERSEA AND HYPERBARIC MEDICAL SOCIETY ANNUAL SCIENTIFIC MEETING AND THE TWELFTH ANNUAL CONFERENCE ON CLINICAL APPLICATON OF HYPERBARIC OXYGEN

CEREBRAL DECOMPRESSION SICKNESS: BUBBLE DISTRIBUTION IN DOGS IN THE TRENDELENBERG POSITION. B.D. Butler, J. Katz*, B.C. Leiman*, R.D. Warters* and T. Sutton. Department of Anesthesiology, University of Texas Medical School, Houston, TX 77030 and MBI, University of Texas Medical Branch, Galveston, Texas.

Severe decompression sickness can result in cerebral air embolism. Treatment modalities include O_2 therapy, placement of the patient in the Trendelenberg position (TP)[2] and hyperbaric recompression. Use of the TP is based in part on the premise that bubbles will "float" away from the brain. We have examined the effects of 0°, 10°, 15° and 30° TP on the distribution of arterial bubbles injected into either the left ventricle or ascending aorta of dogs. Ten dogs were anesthetized with thiopental (25 mg/kg) and maintained with halothane or isoflurane and were embolized with 0.5 or 1.0 ml of room air injected at 1 ml/sec. Doppler monitors placed over the left common carotid artery detected bubbles passing into the cerebral circulation and over the abdominal aorta detected bubbles moving away from the head. Doppler detected bubbles were recorded at each position from either injection site from a total of 60 trials. In vitro studies were also conducted using a simulated carotid artery at normal flow rates to determine the effects of bubble size and vessel angle on the movement of bubbles (0.085-0.4 cm). As bubble size increased, velocity of the bubble decreased at 90°, remained unchanged at 30° and increased slightly at 10° TP. It is concluded that TP does not prevent bubbles from passing from the left ventricle into the carotid artery.

DECOMPRESSION SICKNESS IN WOMEN DIVERS. K.M. Zwingelberg, M.A. Knight* and J.B. Biles*. Naval Diving and Salvage Training Center, Panama City, FL 32405.

The incidence of DCS in women has been controversial for years. Diving log data from the Naval Diving and Salvage Training Center (NDSTC), Panama City, Florida, demonstrates that there is no increased risk of DCS among student female divers compared to their male counterparts. Twenty-eight female students were compared to their 487 male classmates on 878 air and helium-oxygen dives between 4.64 and 10.10 ATA (120 to 300 fsw). None of the women experienced DCS while eight men developed DCS symptoms. The total duration of the dives ranged from 8 minutes to 2 hours and minutes; bottom times were less than 20 minutes. Body tissue inert gas supersaturation on these profiles are commensurate with those experienced on 40 to 60 minute sport scuba dives. NDSTC data and current theories on tissue inert gas saturation and desaturation demonstrate that female divers are at no greater risk of sustaining DCS than males under similar dive exposures within the parameters as examined. This study must be viewed as supportive data dispelling the notion that women are more susceptible to diving DCS than men. However, caution must be taken not to generalize the results of this study beyond what the data will support. Long duration or saturation diving will yield different inert gas tissue parameters than experienced during this study. The question as to DCS incidence for women in these situations is yet to be looked at.

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DIVER ATTACKED BY MERMAIDS ?

Scuba diver Maria Castanhara was caught in a night-marish fight for her life when she was savagely attacked by legendary creatures believed to exist only in the minds of shipwrecked sailors - a band of mermaids!

The 24-year-old Brazilian beauty said only the fear that no-one would ever know what happened to her gave her the strength and determination to survive her incredible ordeal in the crystal-clear Caribbean waters off Mexico's Yucatan Peninsula.

"I thought I was going to die," Maria told authorities only hours after her harrowing escape from the creatures of the deep. "There were four of the beasts and there is no doubt they wanted to kill me.

"And they WERE beasts! I've never believed in mermaids, but in stories I've read they are supposed to be irresistibly beautiful women. The creatures that closed in on me were definitely female - they had human breasts - but they were horribly ugly things! The human part of their body was covered with slime and swarming with tiny sea animals and their hair was like long oily seaweed. They weren't beautiful.

"At first, I simply couldn't believe my eyes," she said. "I thought that I was having rapture of the deep, but I was only 40 feet below the surface.

"Then one of them grabbed at my mask and I felt its slimy skin. It was ghastly, like the flesh of a corpse. It narrowly missed pulling my mask off. I would be dead now if that had happened.

"I tried to get back to the surface, but every time I started up, I felt an icy, oily hand grab my leg and pull me back down. I realized that the only chance I had to survive was to fight as hard as I could."

Maria said that at no time did the mermaids attack her as a group. Instead, each awaited its turn to pounce.

"I tried desperately to control my breathing," she said. "I had almost a full tank of air when the beasts attacked, but I knew that if I panicked, I would gulp that down in just a few minutes. Then I would be a goner. I just kept kicking and punching with all my strength, but I knew I couldn't keep on fighting much longer. And then, just like that, they were gone. For some reason or another, they just left me. I pulled myself up and swam back to the dive boat. Now, sometimes I ask myself if it really happened. I tell myself such things are impossible. Then the terror comes rushing back and the reality is something I can't deny."

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By Ed SPUMS J

A case for PROJECT STICKYBEAK perhaps !

ROYAL ADELAIDE HOSPITAL HYPERBARIC MEDICINE UNIT

Courses in Diving and Hyperbaric Medicine 1988

Basic Course in Diving Medicine

Content Concentrates on the assessment of fitness for candidates for diving. Health and Safety Executive (UK) approved course.

Venue and date

Royal Adelaide Hospital, Adelaide
12-16 September 1988

Cost $A 250.00

Advanced Course in Diving and Hyperbaric Medicine.

Content Discusses the diving-related and other emergency indications for hyperbaric therapy

Venue and date

Royal Adelaide Hospital, Adelaide.
19-23 September 1988

Cost $A 250.00

For Further information and enrollment

Dr D.F.Gorman,
Director Hyperbaric Medical Unit,
Royal Adelaide Hospital,
North Terrace,
Adelaide,
South Australia 5000.
Telephone (08) 224 5116.

PROJECT STICKYBEAK

This project is an ongoing investigation seeking to document all types and severities of diving- related accidents. Information, all of which is treated 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 organisation to increase diving safety through better awareness of critical factors. Information may be sent (in confidence) to:

Dr D. Walker
P.O. Box 120,
Narrabeen,
N.S.W. 2101.

JOIN THE OLDEST SCIENTIFIC SOCIETY IN AUSTRALIA FOR A WEEKEND OF THE LATEST ON DIVING AND HYPERBARIC MEDICINE

Attend the SPUMS, Royal Society of Tasmania and Royal Hobart Hospital joint meeting in HOBART on Friday 4th, Saturday 5th and Sunday 6th of November 1988

If you wish to attend or for further details write to

Dr Peter McCartney,
GPO Box 1317 N,
Hobart,
Tasmania 7001.