South pacific underwater medicine society

Journal/*Newsletter*

C O N T E N T S

NOTE: The following articles will appear in a later issue of the Journal:

(1) Unconscious Diver Survey
by Dr Childs

(2) An article on Physical Fitness
by Dr Nick Flemming

(3) Apologies for the incorrect description of Dr HARPUR MD

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Editorial

It was a happy chance that led Sir Isaac Newton to compare his discoveries with those of a little boy playing on the sea-shore and finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before him. Those involved in Diving Medicine are indeed entering the ocean and when they report their experiences and findings they make it possible for themselves or others to recognise that another fragment of information has been obtained from that greater ocean of Harvey's simile. Hopefully from time to time other "smooth pebbles and pretty shells" will be constructed from such fragments of information, but at the present time we are largely coming to recognise the need to reassemble some of the information already at hand. As recognition of ignorance must precede learning, this need not dismay us too greatly. The papers in Journals such as this may supply a missing piece of information to some reader, cast a query on a accepted present theory, or even confirm a belief. And to sweeten the pill of Theory and Practice you get sharks and sex: naturally both bring problems in diving.

Theory is presented by Dr George Bond's (too brief) note on his personal views and practical experience. It is hoped that further papers will be available from this author, one of the more recent "translations" from the US Navy diving medicine elite to Civil diving. One indicator of the inadequate nature of past interest in, and involvement with, divers had been the tardy recognition of unconsciousness in Commercial (Oil Rig) divers. It is now apparent that episodes are far more frequent than previously believed and there is present investigation into this matter in the North Sea area. This, under the sponsorship of the Department of Energy, is briefly brought to our notice by Dr Childs. It is noteworthy that divers, including the Supervisors, were presumably not reporting the cases because no lasting ill effects were observed. Are other matters similarly being left unmentioned on the "let sleeping dogs lie" principle? The growing awareness among divers and diving contractors of the value of reporting schemes is a sign that diving is evolving from the wild frontier morality towards the recognition that no man is an island, complete in himself.

It is a strange paradox that the demonstration by women of their equality with men should have led to a recognition that they are significantly different. Till recently Medicine has regarded women as being the same as men except in the most obvious ways, while anatomists have regarded them as the basic type from which the male was developed: the religious folk have offered views also. But now we have Dr Bassett and others showing that, in diving at least, women don't behave physiologically in the male manner. Professor Higgins, your hope is vain. Perhaps we should be demanding HIS and HERS diving tables (and compromise ones for those so wishing). What a set-back to progress if it should be shown that men made the best Aquanauts and women the better Astronauts. Perish the thought. But the case presented by Dr Bond indicates that there may be practical consequences arising from the different susceptibilities to DCS. It may be a factor wise divers make allowance for without awaiting official confirmation.

Physical fitness is the one universally accepted shibboleth in Diving Medicine, all new diving candidates being measured against CZ18, the computer age Procrustes. One of the most remarkable of Theseus figures to face this tyrant has been Dr Nick Flemming. We are now pleased to record another valiant fighter for the flexible approach to the concept of FITNESS, Debie and her Instructors deserve cautious praise, for the risks they faced and face from undertaking her training were and remain formidable. Courage and tenacity of purpose shown here and in other cases illustrate that the "X" factor of the diver him (or her) self must be included in the dive equation.

The only acceptable excuse for the existence of diving medicine as an integral part of the world of divers is its claim to advise on the prevention and treatment of diving related morbidity. It is in such a context that special welcome is afforded Dr Carl Edmond's definitive article on the place of in-water oxygen therapy for decompression sickness. Few, if any, go through life without being told "if you can't be good, be careful", so read this article carefully if intending to dive away from ready access to a Chamber facility. DCS being of a maverick disposition even the most careful diver can be "hit".

Prevention should always have pride of place in disaster planning, so the papers reproduced from the US Navy's FACEPLATE have a wide relevance. The "Perils of Pauline" adventures of Professor Nemiroff's patient show that survival can be an unexpected as was the spinal hit in Dr Bond's report. The advice on correct radiological checking of bones of divers is timely, for there is a present climate of opinion that one can have to many exposures to X-rays. One should always remember the films that end in the discard have also exposed the patient to irradiation, an added reason for restricting surveys to a few experienced radiographers and radiologists.

Are we in Australia, organised to undertake trustworthy and researchers valuable medical reviews of divers at this time?

It would be unthinkable to omit mention of Wade Doak, whose book on Sharks and men is reviewed, and Peter Harrigan whose cartoon enlivens our pages once again, while Dr Pahen makes the touch of a Sea Wasp sound as fearsome as any shark. We thank all contributors and those original publishers who have permitted papers to be reprinted.

Meeting at the School of Underwater Medicine, 3 March 1979

Many members and their families attended their first SPUMS meeting at the SUM.

The meeting commenced with a guided tour of the School buildings, the milling throng being granted views of both the recognisable medical equipment and the electronic marvels that only Scientific Officers dare claim to understand. Then all were invited to view some diver volunteers(?) demonstrate three diving sets: air, nitrogen-oxygen, and oxygen. The weather ensured that the spectators appreciated the wetness of the diving environment but very luckily cleared in good time for the BBQ to proceed without hitch. Thanks are due to those who prepared the food and to the RAN diver who performed the cooking duties, and also to our Treasurer who did his best to ensure the financial success of the meeting. In the afternoon the non divers were free to use the pool while the others went to hear the papers prepared for their entertainment and education.

The first speaker was Bob Wallace, who is intimately involved in underwater photography and the organising of conferences. He was followed by Dr Robert Layne, much involved in Emergency Department medicine in California. He told of the different conditions met with in Northern and Southern California, the

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Spinal Bends: a Case and Some Comments

George F Bond, MD

This case is presented in the form of a letter and reply, as that is the way it was.

Dear Dr Bond

I have read about your pioneer advanced in underwater technology and the formation of the Institute of Diving. I hope that you might be of benefit to me, or at least point me in the right direction. In April my wife suffered decompression sickness with injuries to the spinal cord in the C5 and L4, and possible S4-5 area. This was while we were diving in West Palm Beach, Florida.

The dive was maximum depth of 80 feet, average depth being 70 feet, bottom time was 30 minutes. This was the first dive of the day and following the injury my wife went through three hyperbaric oxygen treatments totally some 19 hours. She is showing gradual and sustained improvement in her neurologic deficits at this time. However, I am extremely interested in pursuing the etiology of this for our personal satisfaction as well as the possibility that it might be of assistance to another sport diver in preventing this tragedy. My wife is 37 and was in excellent physical health, playing tennis five days a week and running some three to five miles a week. Following her recompression, she has been worked up extensively with a barrage of lab work, spinal taps and computerised head and body scans, all of which have been within normal limits.

One of the main questions is why this happened, since we were well within the Navy tables, we were diving with a dive master, and there were no infractions of diving rules. In addition to wondering about the etiology there is the question whether it would be safe (or even advisable) for her to dive again since she did receive multiple injuries from the decompression illness the first time. This was not her first dive to 80 feet, not the hardest or most dangerous as far as decompression illness is concerned. She was examined by two internists who have had training in hyperbaric medicine, but both of us would like her to be evaluated by a professional who specialises in hyperbaric medicine with extensive knowledge in decompression sickness. I would appreciate it if you could assist me with this task.

Sincerely
"ABC", MD

Dear Doctor C

It is always disturbing to hear of yet another spinal cord "hit" following a routine and well executed sports dive. I wish that I could call it a one in a million occurrence in the list book of decompression casualties, but such is simply not the case, which underscores our meagre knowledge of the etiology of bends involving the spinal cord. Let me elaborate on this a bit.

Firstly, about twenty percent of spinal cord "hits" follow clean, non-repetitive dives. Depth does not seem to be a factor, but in practically every case the dive has approached the no-decompression limits. Characteristically, in the 50-odd cases I've treated, the victim has surfaced in a normal physical state and then, within a surface interval ranging from 20 minutes to 12 hours, has experienced upper lumbar pain which rapidly became girdle-like in character, simulating most closely the syndrome of <u>Tabes Dorsalis</u>, which we rarely see nowadays in practice. At this point the stricken diver reports that he (or she) must have stressed his or her back during the dive, and proceeds to lie down of deck for relief. Minutes or hours later the victim discovers ill-defined paraesthesias of the lower extremities, and discovers motor paralysis as well. Bladder involvement does not become apparent for some hours.

Physical examination of this typical case reveals an apprehensive patient with quite normal vital signs with respect to all but the spinal cord component of the CNS. Ordinarily, the somatic involvement at lower segments as well. Anterior and posterior horn abnormalities will be noted, in varying degrees of severity. There will be present degrees of flaccid paralysis of the lower extremities, with positive Babinskis, ankle clonus, positive chaddock, absent cremasterics, and weak or absent abdominal reflexes. Position sense is generally absent. In short, we have an instant paraplegic.

The treatment of this dive paraplegic is pretty well established, though through trial practice, not extensive research. US Navy Table 6-A is the primary treatment of choice, since this combines the desiderata of rapid, deep recompression for reduction of bubble size with subsequent oxygen drenching to relieve the hypoxis neural tissue of the spinal cord. This therapeutic protocol may be repeated at suitable intervals, or until the hazard of pulmonary oxygen toxicity becomes too great. On rare occasions after apparent failure of the 6-A therapy one might try Table IV, although very few of us would advocate this final gesture, since it holds virtually no promise, save further physical hazard to the patient thanks to a mandatory 34 to 38 hour stay under pressure. Still, Table IV is in the book, and some would use it in such a case to clear decks in case of future litigation. An added note is in order: all spinal cord “hits” customarily are given a 3-day course of Decadron, to avoid anticipated cord oedema, and such other supportive therapy as may be deemed necessary.

Let us now return to your wife’s case. I cannot explain her spinal “hit” which seems so cruel in light of her obvious adherence to safe diving practices. I can only say that the US Navy Diving Tables were not formulated to produce zero incidence of decompression sickness, but rather to hold the incidence to a level compatible with effective diving operations. Unfortunately, the general public has been led to believe that the Navy Tables afford a complete shroud of safety. This, of course, is not the case, as witness my own history of seven hits (one spinal) in 22 years of diving. Nonetheless, these Tables are the best we have, and I still cling to them. They are, however, devised for divers with a median age of less than 26. At my age of 62, I tend to add a few minutes of decompression, here and there. Certainly, past age 35, it would be well to nudge the no-decompression limits too closely.

All of this, of course, does not speak to the question: Why, in such a dive, do we get a spinal hit instead of a fortunate “pain only” joint involvement? This I cannot answer. My friend and colleague, Dr John Hallinbeck, NMRI, Bethesda, Maryland has done elegant laboratory experimental work in animals, and will tell you of the venous lake which commences at T-10, and predisposes to impaired venous flow and subsequent bubble formation, with CNS involvement; but even John cannot answer the question: why? In some respects decompression is an ubiquitous disease; but that does not forgive our research shortcomings, which must be pinpointed before we can deal from a full deck. To conclude this paragraph, however, I must make the point that spinal cord bends is least common among US Navy divers, next (by an order of magnitude) among commercial divers, then (by almost three orders of magnitude) among civilian sport divers. In honest analysis, consider these facts:

1. Navy diving is done with calibrated stopwatches, calibrated pneumofathometers, and calibrated depth gauges;
2. commercial divers do not adhere to Navy Tables for decompression and, on occasions, deviate from standard rules of diving safety, though not often;
3. civilian divers rarely follow US Navy dive protocols, often rely on wrist-held decommeters, do not adhere to stopwatch precision, trust too often to the accuracy of the dive boat fathometer, and are often in error relative to up and down excursions in the water column.

Diving physiology is far from an exact science but, when we see such a wide variance from the pragmatic limits established, many of us in this game tend to shake our heads and say unprintables.

Now and more importantly, back to your wife’s case. Assuming that her calculation of bottom time (surface to bottom to leave bottom) was correct, that the dive ship fathometer was correctly calibrated, that she did not return to near-surface during the dive, then one must say that she falls into the 20% group of unexplained spinal cord “hits”. Before I can give you a final judgement in this case, I’d surely like to have all diving and treatment logs, as well as a definitive neurologic history and current evaluation.

As consolation may I say that, in my experience, the history of your wife’s progressive recovery speaks well for near complete recovery save for a slight foot drop and mild urinary difficulty. Please write me back. The bottom line, however, is she should NEVER DIVE AGAIN!

Sincerely yours,
George F Bond, MD

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former being far more rugged (cold, poor visibility and heavy surf sounded less than appealing compared with the southern area). He noted the “will dive” feeling that affects those who have travelled a long distance to reach the dive area, such as Monterey Peninsular, and are not going to sit and watch the sea whatever the conditions. This explains the experience Dr Hattori has obtained treating diving casualties (we have had a paper from him in these pages). Then Dr Gunter Silins told us about the Tobermory area in Canada where one could only dive for 2 and a half months in the year and cold was a very real factor in every dive. Apparently any “designated diving area” <u>must</u> have a hyperbaric unit available, a requirement presumably based on experience. Dr Harpur, whose paper on the free ascent problem appeared in our last issue, is Medical Director of this hyperbaric unit. Three cases were reported of diving incidents, in one of which the dangers of entering a chamber with a disorientated patient were described. The victim was snatched back from a state of almost death and took time to accept the reason for being “potted”. The last speaker was Dr Peter McCartney from Tasmania, who notified his intent to investigate different buoyancy compensators.

The meeting was both a social and a diving-medicine success, a credit to all those involved.

Safe Diving Equals Fun Diving: Prescriptions for Diving Women

Bruce E Bassett, PhD

Formerly Aerospace Physiologist, Lt Col USAF, USAF School of Aerospace Medicine, Brookes AFB, Texas. Now President of Human Underwater Biology Inc, San Antonio, Texas.

This paper was presented at IQ 10/1978 and we are grateful to NAUI for permission to reprint it and the author for offering it to us.

Susceptibility of Women to Decompression Sickness

The classical publications on decompression sickness (DCS) do not contain any information on the relationship between sex and susceptibility to DCS because of a lack of data regarding exposures of women. Records covering the last ten years of altitude chamber exposures at the USAF School of Aerospace Medicine (USAFSAM) indicate there is statistically significant four fold greater incidence of altitude DCS in women than in men (women 5, 791 exposures; 17 cases DCS, incidence 0.09%. Significance in difference tested by Chi^2, P 0.0005).

One additional subgroup with an apparently greater incidence of DCS than the women exposed at the USAFSAM are the female AFA cadets trained at Peterson AFB. However, the numbers in this group are too small for statistical comparisons with any of the other subgroups (female AFA cadets: 155 exposures; three cases DCS; incidence 1.935%)

Additional information and data were obtained from analyses of 104 USAF-wide cases of altitude DCS treated by recompression during the 12 year period from 1966 through 1977. Of these 104 cases, 32 (31%) occurred in women. In comparing individual factors (age, height, weight, etc) exposure factors (type and symptoms of DCS, recurrences, symptom onset, etc) between the men and women treated, a few significant difference, besides sex itself, were found. These findings will be presented.

A 26 year old woman diver, active in sports and in excellent physical condition, made a dive to 70 feet for about 5 minutes, then to about 50 feet for 29 minutes. Water temperature was 82°F, the diver wore a flight suit for protection and was diving with a very experienced buddy. Upon surfacing, the Repetitive Group for a 70 foot/34 minute schedule was assigned, ie. Group G. One hour 38 minutes were spent on the beach drinking coffee and relaxing prior to making a second dive to 45 feet for 43 minutes. Both dives were without incident except that the woman felt much colder than on any of her previous ten logged dives, in fact the second dive was terminated due to chilling.

Upon exiting the second dive, she experience severe back pains but felt the pains were normal in that her menstrual period was due to start in two days. However, she noted that the back pains were worse than normal. Following the dive she put away her gear and upon arrival home went to bed due to the persisting and worsening back pains. No medication was taken and the general discomfort and back pains grew in intensity. By six hours post dive her worsening condition was the onset of pain in the knee joints caused her to seek medical help. She was placed in oxygen at the medical facility and transported to a nearby US Navy recompression facility.

The diver was taken to 60 feet on US Navy Treatment Table 5, with almost immediate relief in most joints. During the course of treatment her back pain recurred so treatment was completed on Treatment Table 6. One hour after completing Table 6 the woman started having tingling sensations so was re-treated in the chamber. Apparently, there were some residual deficits noted following the second treatment which resolved over a period of a few days. She was subsequently recertified medically for diving and has continued her diving without untoward reaction.

Possible contributing factors in this case include the fact that the night before the dives she took two birth control pills at 11 pm having missed taking one the day before, and the fact that the diver is a heavy smoker. She had smoked half a pack of cigarettes between the time she got up and her first dive on the day of the reaction. She had also smoked about 9 cigarettes during the surface interval between dives.[1]

If the classical publications on the subject of decompression sickness are read, one will find that the subject of sex as a factor in determining susceptibility of decompression sickness (DCS) is dealt with in three words - “no data available”.[2,3] With respect to diving, especially in sport diving, this is still the case and will in all likelihood remain so - “no data available”!

Yet there are anatomical and physiological differences between the sexes that can be hypothesized to result in an increased susceptibility to DCS among women. The factors, which might be expected to increase the risk of DCS in women, include a greater proportion and different distribution of body fat, fluid shifts and fluid retention (oedema) as related to the menstrual cycle, cyclic hormonal changes, and use of oral contraceptives. Other questions with respect to any hypothetically greater susceptibility to DCS in women that need answers include:

1. Are there perfusion anomalies found in women or more prevalent in women that could be related to an increased probability of bubble formation?

2. Are there haemotological differences, which are more prevalent in women, that could be related to platelet aggregation triggered by bubbles?

3. Are vasospastic phenomena or release of vasoactive substances, as may be caused by bubbles, more likely to be found in some or all women?

While little or no laboratory research has been conducted in the area of differences in DCS between the sexes, there is data available now that does indicate a greater susceptibility among women. This data was gathered on women exposed to high altitudes in the US Air Force’s altitude chamber indoctrination program.[4] In most respects altitude DCS is the same as DCS encountered in diving. There are some differences which may make the extrapolation to diving somewhat confusion, but when individual case histories are compared there are also many similarities. During the 12 year period from 1966 through 1977 there were 104 individuals treated by recompression for altitude DCS, 32 (31%) of whom were women. More detailed records were available at the USAF School of Aerospace Medicine where 22 of the 32 DCS cases in women occurred. This allowed for a determination of the incidence (ie. # of cases/# of exposures) if DCS for both men and women exposed to altitude for the 10 year period from 1968 through 1977. The incidence in men was 0.09% while in women it was 0.36%, and this four fold greater incidence is statistically significant to P 0.0005.

In comparing, among all 104 USAF-wide cases, individual factors (age, height, weight, etc), exposure factors (type of exposure, exposure time, prior exposures, etc) and case data (type and symptoms of DCS, recurrences, symptom onset, etc) between the men and women treated for altitude DCS a few significant differences, besides sex itself, were found. Within the category of individual factors the women were significantly different from the men in height, weight and body build - certainly not an original observation! However, size and slender build are generally associated with a reduced risk of DCS, not an increased susceptibility as found in this data. There was also statistical significance in the larger number of women who reported a history of vascular or migraine headaches and previous altitude reactions. In the category of exposure factors, women with DCS had attained a lower maximum exposure altitude than the men, but this data is biased by the fact that since 1973 women have generally been exposed to lower altitude profiles in the altitude chamber. Nevertheless, this finding would support the finding of a greater susceptibility to DCS. Regarding case data, significantly more women had the onset of bends pain at altitude than men and more women had cutaneous (skin) manifestations than men. Finally, while the numbers are too small to test statistically, 7 (22%) of the women treated had recurrences of manifestations either during or following recompression therapy and required retreatment in the chamber. This only occurred in 2 men (3%). An the only cases which resulted in lasting neurological deficits, in spite of prompt and adequate therapy, occurred in two women.

The conclusions from the data can be summarized as follows. In spite of their smaller mean size and stature, women are four times more susceptible to altitude DCS, have more skin symptoms, have a more rapid onset of bends pain, have more recurrences and lasting effects of DCS when compared to men exposed to the same altitudes in an identical manner. Interestingly, many of these findings are seen in the case history cited at the beginning of this paper. It is tempting, therefore, to hypothesize that the same differences documented in terms of altitude DCS may well be found in diving women.

<u>Prescription</u> Dive conservatively with respect to the decompression limits. Always stay well within the no decompression limits on single and repetitive dives. How much conservatism is enough? There can be no definite answer to this question until studies are, if ever, performed. As a reasonable set of recommendations, reduce the no decompression limits for dives to 90 feet or more by 5 minutes, by 10 minutes for dives shallower than 90 feet, and use total dive time (surface-to-surface time) for the maximum depth of the dive to attain the repetitive group designation.

How about the “Pill” and susceptibility? There are many reasons why oral contraceptives may increase susceptibility to DCS - but there is no evidence because studies have not been done. In the meantime, only the same prescription can be given, DIVE CONSERVATIVELY! As an alternative there may be other birth control methods which a woman diver would find acceptable and which would be less likely to have any effect related to DCS susceptibility or severity. A relatively new method of birth control that appears effective and convenient is the Progrestasert System.[5] This interuterine device differs from the “normal” IUD in that it is a hormonal regulator like the Pill, but the hormone acts directly on the uterus and not via the circulation. Therefore, it would not be expected to have any synergistic effect on women divers. Jo Ann Wesner, a diving instructor in Illinois kindly provided this author with the information on the Progrestasert System and is attempting to gather data on its use by divers. I encourage all of you interested in this system or who are using it to contact Jo Ann directly.

Thermal Balance in Women Divers

As previously stated, women have a higher proportion (and more interesting distribution) of body fat compared to men. This layer of subcutaneous fat should and does serve as a good insulator due to the lower thermal conductivity of fat. Why them is it a common observation among divers that many women suffer the effects of diving in cold water sooner than their male counterparts?

In a 1974 study on the metabolic and thermal responses of women during cooling in water it was found that an individual’s sensitivity to cold was based on two factors: 1. the percentage of body fat, and 2. the ratio of surface to body mass.[6] It was observed that lean women who had less than 27 percent body fat had a large ratio of surface area to body mass, and this resulted in cooling at a faster rate. Above 30 per cent body fat, men and women were equal in their sensitivity to cooling and maintained similar low levels of heat production in cool water.

On the other end of the scale, a woman is also likely to suffer from over heating sooner than the male, since sweating in women does not begin until their body temperature rise is 2° to 3° higher than males. In addition, the woman has a lesser number of functioning sweat glands to aid in evaporative heat loss.[7]

Prescription Anyone, man or woman, who cools easily should use appropriate thermal protection in the form of a properly fitting wet or dry suit. Don’t base your requirement for thermal comfort when diving on what your buddy or other divers use in the same water - if you need a uni-suit to remain comfortable in Cayman waters while everyone else is in a bikini, wear it - it’s your body!

During rather lengthy periods of carrying heavy equipment, suiting up or otherwise getting overheated during the hot summer months, the woman diver should periodically cool off by an occasional dunking in the water if at all possible. Starting a dive in an overheated condition is not only miserable, it is also unsafe.

Diving During Menstruation

The general advice given to women regarding physical activity during the menstrual period is “if you feel well, do it”. This seems to be valid since the menstrual period did not prevent women from winning medals in the Olympics of 1972 and 1976. On the other hand, if the woman experiences severe cramps or discomfort, it is unwise to engage in strenuous physical activity.

Knowledge concerning the state of the menstrual cycle and susceptibility to decompression sickness, narcosis or any other diving related problem is general lacking. However, there are some working hypotheses that may make the advice that “if you feel well, do it” not necessarily sound with respect to diving. For example, fluid retention and endema preceding and during the menstrual period may impair blood flow and inert gas elimination, giving an increased likelihood of bubble formation and decompression sickness.

What is the danger of shark attack for a menstruating women diver? The cyclic shedding of the lining of the uterus, under hormonal control, results in a loss of approximately 50 to 150 cubic centimetres of blood and cellular debris over the average of three to five days.

Prescription Regarding diving during or just prior to menstrual period, the only advice is that previously given, ie. dive conservatively. Stay well within the no decompression limits.

Regarding sharks, the small quantity of blood lost during any given dive, the use of internally worn tampons, and the lack of any evidence of shark interest in a menstruating diver leads to the conclusion that the woman should forget about sharks and enjoy her dive.[8]

Diving While Pregnant

As previously indicated, there is a lack of data regarding women divers, specifically pregnant divers. However, it is known now that dives made near the limits of the no-decompression tables can produce intravascular bubbling in many subjects, even without the development of symptoms. What is not known is whether such bubbles will form in the developing fetus on such dives. One study conducted in dogs indicated that the feti were resistant to bubble formation even when the mother displayed marked bubbling following decompression and even though the amniotic fluid surrounding the feti contained numerous large bubbles.[9] A more recent study in sheep produced the opposite results, ie. more bubbles in the fetus than in the mother.[10] While human observations may never be performed, the consequences of any bubble formation in the developing fetus could prove to be disastrous.

Another consideration is the possible effect of elevated oxygen partial pressures on the unborn children of pregnant divers. While breathing air at depths of 30 feet or less does not raise the partial pressure of oxygen to levels that might be predicted to cause difficulties, breathing air at 124 feet produces an oxygen pressure equal to breathing 100 per cent oxygen at sea level. Pressures of oxygen this high are known to produce retinal damage, resulting in blindness, in premature infants. Therefore, the unborn child might be expected to be very sensitive to elevated oxygen pressures that could be encountered in scuba diving. Again no direct studies have been conducted.

Other factors in pregnancy may present difficulties to the diver, ie. nausea, fatigue, backaches, clumsiness and poorly fitting equipment. Hormonal and physiological changes, including fluid retention and increased fat stores, may increase the risk of decompression sickness in the pregnant diver.[8]

Around the fourth month of pregnancy there is usually increased swelling and sensitivity of the mucous membranes which may give rise to difficulties with equalizing middle ear and sinus pressures.[8]

One last consideration concerns the possible effects of treatment of a pregnant diver with decompression sickness. Present treatment schedules call for the use of 100 per cent oxygen at 60 feet equivalent depth in the recompression chamber. This raises the arterial oxygen pressure from a normal 100mm Hg to over 2000mm Hg. This high an oxygen pressure would almost undoubtably have disastrous effect on the vulnerable fetus, yet the only recourse would be to treat the stricken mother.

Prescription The Undersea Medical Society guidelines for scuba diving while pregnant are protectively conservative, ie. NO SCUBA diving deeper than 30 feet, and avoidance of decompression diving. The second recommendation, of course, should apply to all sport divers.

After delivery it is generally recommended that the new mother avoid diving for six weeks to preclude the possibility of uterine infection.

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Public Health an N.S.W. initiative

Human “guinea pigs” will eat oyster to see if they are safe, the NSW Parliament was told yesterday. The Conservation and Water Resources Minister, Mr Lin Gordon, said the panel of volunteers would eat oysters to find out if they contained a harmful virus. He said the test was part of a research program set up by the Fisheries Department and the Health Commission and costing $120,000. When a grower felt his oysters were ready for sale to the public, the would be tested by the Health Department to see if the bacteria count was at an acceptable level. “Further to that, there will be testing panels which will test to see if any virus is present in the oysters. This can only be done by a panel of volunteers, who will eat the oysters. Of course it’s a kind of Russian roulette.” Four or five months ago more than 2,000 cases of gastroenteritis were reported after people had eaten oysters. “This was said by the Health Commission to be the largest outbreak of food poisoning ever to happen in Australia, and possibly the world” he said. (Daily Telegraph 16 Nov 78)

Debi Diver
Thom Lustik

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Her name is Debie, and she's just like you and I - at least she *was* just like you and I until a car wreck put her into a wheelchair for the rest of her life! Before the accident, Debie used to run, swim, dance and dream about the future just like the rest of us; but Debie can't do these things any more, or can she?

I met Debie two years ago at the medical clinic I run. From the moment we met, I sensed her determination to live and adapt to her paraplegia. It seemed almost natural to invite her to enrol in my next scuba course. I guess I wasn't surprised when she said she would love to learn to dive.

After I considered the problems I was letting myself into by offering to teach a paraplegic to dive, I began to look for reasons to back out of my offer. To put it another way, I became somewhat prejudiced. But, Debie was persistent, and her enthusiasm was infectious. Today, I thank Debie for her persistence.

The first problem I anticipated was medical approval; but to my surprise, Debie's physician indicated that just because her legs were paralyzed didn't mean that Debie's health was compromised. She was given unconditional medical approval.

Next I had to evaluate Debie's watermanship. Swimming had been an integral part of her physical therapy after the accident. Without the use of her legs, Debie's arms became the supporting limbs of her body, and swimming helped develop her arms. As a result, she passed her swim test with flying colours.

Now began the real meat of the courses - the pool training. I was fortunate to have a fantastic pool staff who were as enthused as I was about teaching scuba to our handicapped student. Mike Wright, a PADI instructor, and Bussie Melnick, owner of Albuquerque Diver's Den, had enough faith to back me in both the teaching of a handicapped student as well as the choice of this particular student herself. The three of us tossed around ideas on how to adapt Debie to the underwater environment.

Our first pool session taught us a number of lessons about the trim of a paraplegic diver. Debie's legs, which were useless to her, would tend to float anywhere they pleased, upsetting their trim. By the second pool session, we came up with a solution to this problem by creating a set of thigh weights fashioned out of neoprene, velcro, and two pounds of lead shot. When attached to Debie's mid-thigh, her legs stayed just about where they should have been.

After one problem was solved, it seemed another would crop up. Debie's next problem was with the scuba equipment itself. We round that by using a conventional horse collar BC and tank system, Debie would tend to roll over on her back. Mike, Bussie, Debie and I put our heads together again. (Its interesting to note that by this time Debie was the leading authority on the problems she was encountering while adapting to the underwater world). The answer we came up with was a back flotation system.

Within a week, Debie's tank mounted BC was delivered to the Diver's Den. The next water session proved that our idea worked. The tank mounted BC system allowed Debie full freedom of movement underwater. Debie was delighted with the equipment and, from that point on, progressed to her final pool skill without any major difficulty.

From my point of view, Debie had progressed as well as any non-handicapped student. Of course there were some special adaptations that her classmates as well as the instructional staff had to make; such as, helping Debie into the pool from her chair and allowing a little extra time for her to suit up. But all in all, everyone was more than willing to help. I think Debie's participation in the class formed a bond between the students and staff which we will all long remember.

Debie has completed all necessary open water work for her certification. She acknowledges that because of her handicap, there are practical limitations to her diving experiences. She knows that certain procedures have been developed for her, and that in order to safely practice her sport, she must follow these procedures. I have listed below some ideas we developed during Debie's course that PADI instructors who accept the challenge of training handicapped students might use to help develop their own programs.

1. High-top tennis shoes will protect the foot and ankle from injury of rough pool sides and bottoms. I have found that wet suit boots protect the same areas; however, they are all but impossible to put on the student's foot without an elaborate zipper system.

2. Paraplegic students are more susceptible than non-handicapped students to hypothermia because of the nature of their handicap. Therefore, a full wet suit is essential in all water training. Also, a zip-on type suit for the paraplegic diver.

3. As I already indicated, thigh weights help keep the legs down in a simulated swimming position. Weights can be attached using velcro or can be inserted into pockets sewn directly on the wet suit.

4. Back flotation devices tend to work well both on the surface and underwater. The stabilizing vest by Seatec is an excellent system for use by paraplegics.

5. Ping-pong paddles with lanyards attached to the handles and secured around the diver's wrists make excellent "hand fins". When not in use, these "fins" trail from the diver's wrists; and when in use, the diver grabs the handles and used the paddles to propel herself through the water. In addition to the paddles, I have found that a lanyard attached to a buddy's tank allows the handicapped diver to hand on for a ride in certain situations.

I think that every Instructor should give some thought to offering handicapped individuals scuba training. The most important thought to keep in one's mind, however, is the need to instil the principle of diving within the student's own limitations. We as PADI instructors ensure that our non-handicapped students understand this principle, so, why not stress the same principle to a handicapped student? As long as the handicapped student can meet the certification requirements, there should be no reason not to instruct that student. I think that I can safely say from my personal experience, the only difference between training a handicapped and non-handicapped student is the Instructor's attitude towards the student and not the handicap. I urge you to at least consider a training program for the handicapped - I'll guarantee you won't be sorry you did.

Underwater Oxygen Treatment of decompression sickness
Dr Carl Edmonds

Introduction: Since 1970, in remote regions of the Indo-Pacific, a new option was added to the armamentarium for treatment for decompression sickness. It was closely supervised and directed by the respective officers-in-charge of the Royal Australian Navy School of Underwater Medicine. Initially it had no official sanction, but developed in response to an urgent need for management of cases in remote localities - remote in both time and distance from the few hyperbaric facilities. This is elaborated further under the section termed "The Problem".

Because of the success of this treatment, and its ready availability, it became known and practiced, even when the experts were not available to supervise it. The reasons for this were twofold. Firstly, the non-recompression ancillary therapies are not particular efficacious on their own. Secondly, the conventional underwater air decompression treatments posed considerable operational difficulties - elaborated in the section termed "Traditional Solutions".

The techniques of underwater oxygen therapy, and the equipment used, are described under their respective headings. It was designed to make for safety, ease and ready availability, even in medically unsophisticated countries. Advantages and disadvantages of this type of therapy, together with many of the questions that have arisen because of it, are described under the section labelled "Discussions".

The physiological principles on which this treatment is based are well known and not contentious, although the indications for treatment have caused some confusion. Like conventional oxygen therapy tables, it was first applied mainly for the minor cases of decompression sickness, but was subsequently found of considerable use in the potentially serious cases. This is considered under sections labelled "Case Reports" and "Underwater Oxygen in Perspective".

The Problem

For almost two decades the Royal Australian Navy, at the School of Underwater Medicine, accepted responsibility for the treatment of cases of decompression sickness presenting in this part of the Indo-Pacific region. During most of this time, it had the only large recompression chamber permanently staffed with experienced diving medical personnel. The catchment area extended to a radius of about 6,000 kilometres around Sydney, Australia.

Australia is an island continent, with one of the longest habitable coastlines of any single country - approximately 30,000 kilometres - and eminently suited to diving. Amateurs relish the warm waters of the Great Barrier Reef, while professional diving encompasses the pearl, abalone, salvage and oil industries. There are traditional ties, and often protectorate or treaty responsibilities with other countries of the Indo-Pacific. Many of these islands have either very limited or no airport facilities. Medivac of decompression sickness patients to Australia often required a return flight originating in Sydney. Where possible, use was made of aircraft that would be cabin pressurised to ground level, and in many cases there would be a time lapse in excess of 24 hours between the patient being "bent" and receiving treatment. The costs, in time and money, and the commitment of service facilities and aircraft, made treatment of minor cases impracticable. The delays made serious cases worse. As an aggravating factor, the clear warm waters encourage the type of diving which results in severe decompression sickness.

During the middle of the ’70s, the incident rate of decompression sickness reported to the Navy School of Underwater Medicine was approximately one every two weeks. The majority of these cases were far distant from Sydney locality, and in many cases the medivac transfer of these patients to Sydney was not possible.

Traditional Solutions

A whole gamut of treatments, other than the conventional recompression therapy, have been applied to decompression sickness. These include some which have a physiological basis, some which are of interest from the pharmacological aspect, and others which are merely novel in their approach. None have received universal acceptance as an isolated therapy. They include such regimes as: intravenous fluid replacement, with low molecular weight dextran, plasma and other fluids; anticoagulants; anti-lipaemic agents; steroids; hypothermia; etc.

By far the most traditional of the non-chamber treatments, is the underwater recompression therapy. In this situation the pressure is exerted by the water, instead of a recompression chamber. Air supply is usually from compressors sited on the diving boat. Although this treatment is frequently ridiculed by those in the cloistered academic environs, especially when they possess elaborate recompression facilities, it has frequently been the only therapy available to severely injured divers, and has had many successes. This is certainly so in those remote localities such as Northern Australia, in the pearl fishing areas, where long times were spent underwater and standard diving equipment was used. Underwater air treatment continued to be used, in the absence of available recompression chambers.

Despite the value of the underwater recompression therapy, many problems are encountered with it. These are well recognised by both divers and their medical advisers. It is of interest that two of the diving medical text books written in English, do not mention this therapy at any stage! The US Navy Diving Manual briefly mentions it as a possible treatment and recommends the application of the conventional air tables as far as possible and seems to infer that Table 2A is perhaps the acceptable one. This involves taking divers underwater, to a maximum depth of 165 feet or 50 metres and with an overall duration of 11 hours. The Royal Navy Diving Manual recommends a somewhat more reasonable approach with Table 81, at a depth of 100 feet or 30 metres and duration of almost 5 hours. Most of the underwater air treatments are more practical than these and a typical example is that given by Sir Robert Davis, in which the duration depends upon the depth required for relief of symptoms. Most regimes are makeshift, and are varied with experience.

The problems are as follows. Most amateurs or semi-professionals, other than the navies and multinational diving companies, do not carry the compressed air supplies or compressor facilities necessary for the extra decompression. Most have only SCUBA cylinders, or simple portable compressors that will not reliably supply divers (the patient and his attendant) for the depths and durations required. Environmental conditions are not usually conducive to underwater treatment. Often the depth required for these treatments can only be achieved by returning to the open ocean. The advent of night, inclement weather rising seas, tiredness and exhaustion, and boat safety requirements, make the return to the open ocean a very serious decision. Also because of the considerable depth required, hypothermia from the compression of wet suits, becomes very likely. Seasickness, in the injured diver, the diving attendants and the boat tenders, becomes a not inconsiderable problem. Nitrogen narcosis produces added difficulties in the diver and attendant. The treatment has often to be aborted because of this. These difficult circumstances, producing decompression sickness in the attendants, and aggravating it in the diver. Underwater air treatment of decompression sickness is not to be undertaken lightly. In the absence of a recompression chamber, it may be the only treatment available to prevent death or severe disability. Despite considerable criticism from authorities distant from the site, this traditional therapy is recognised by most experienced and practical divers to often be of life saving value.

Underwater Oxygen Therapy

The value of substituting oxygen for air, in the recompression chamber treatment of decompression sickness, is now well established. The pioneering work of Yarborough and Behnke (1939) eventuated in the oxygen tables described by Goodman and Workman (1965). They received widespread acceptance, and revisions and modifications are now incorporated in Tables 5 and 6 by the US Navy Diving Manual, the Comex tables, and the Australian Therapy Tables. The advantages of oxygen over air tables include: increasing nitrogen elimination gradients; avoiding extra nitrogen loads; increasing oxygenation to tissues; decreasing the depth required and the hyperbaric exposure time; and improving the overall therapeutic efficiency. The same arguments are applicable when one compares underwater air and underwater oxygen treatment.

a. Technique

Oxygen is supplied at a maximum depth of 9 metres, from a surface supply. Ascent is commenced after 30 minutes in mild cases, or 60 minutes in severe cases, if significant improvement has occurred. These times may be extended for another 30 minutes, if there has been no improvement. The ascent is at a rate of 12 minutes per metre. After surfacing the patient should be given periods of oxygen breathing, interspersed with air breathing, usually on a one hour on, one hour off basis, with vital capacity measurements and chest x-ray examination if possible.

b. Equipment

The equipment required for this treatment includes the following: a G size oxygen cylinder (220 cu ft or 7000 litres). This is usually available from local hospitals, although in some cases industrial oxygen has been used from engineering workshops. This volume of oxygen, at the depth varying between 9 metres and the surface, is insufficient to produce either neurological or respiratory oxygen toxicity. A 2-stage regulator, set at 550 kPa is fitted with a safety valve, and connects with 12 metres of supply hose. This allows for 9 metres depth, 2 metres from the surface of the water to the cylinder, and 1 metre around the diver. A non-return valve is attached between the supply line and the full face mask. The latter enables the system to be used with a semi-conscious or unwell patient. It reduces the risk of aspiration of sea water, allows the patient tot speak to his attendants, and also permits vomiting to occur without obstructing the respiratory gas supply. The supply line is marked off in distances of 1 metres from the surface to the diver, and is tucked under the weight belt, between the diver’s legs, or is attached to his harness. The diver must be weighted to prevent drifting upwards in an arc.

A diver attendant is always present, and the ascent is controlled by the surface tenders. The duration of the 3 tables are 2 hours 6 minutes; 2 hours 36 minutes, and 3 hours 6 minutes. In the unit currently marketed in Australia by Commonwealth Industrial Gases, there is an optional extra piece of equipment - a positive pressure mask. This allows the unit to be used for the treatment of drowning victims, with intermittent positive pressure oxygen resuscitation.

Discussion

It was originally hoped that this treatment regime would be sufficient for management of minor cases of decompression sickness, and to prevent deterioration of the more severe cases while suitable transport was being arranged. When the regime is applied early, even in the severe cases, the transport is often not required. It is consistent observation that improvement continues throughout the ascent, at 12 minutes per metre. Presumably the resolution of the bubble is more rapid at this ascent rate, than its expansion due to Boyle's law.

Certain other advantages are obvious. During the 3 hours continuous hyperbaric oxygenation, the tissues become effectively denitrogenated. Bubbles are initially reduced in volume, in accordance with the hyperbaric exposure and the resolution is speeded up by increasing the nitrogen gradient from the bubble. Attendant divers are not subjected to the risk of decompression sickness or nitrogen narcosis, and the affected diver is not going to be made worse by premature termination of the treatment, if this is required. Hypothermia is much less likely to develop, because of the enhanced efficiency of the wet suits at these minor depth.

The site chosen can be in a shallow protected area, reducing the influence of weather on the patient, the diving attendants and boat tenders. Communications between the diver and the attendants are not difficult, and the situation is not as stressful as the deeper, longer, underwater air treatments or even as worrying as in some recompression chambers. (When hyperbaric chambers are used in remote localities, often with inadequate equipment and insufficiently trained personnel, there is an appreciable danger from both fire and explosion. There is the added difficulty in dealing with inexperienced medical personnel not ensuring an adequate face seal for the mask. These problems are not encountered in the underwater environment.

Underwater Oxygen - Perspective

The underwater oxygen treatment table is an application, and a modification of current regimes. It is not meant to replace the formal treatment techniques of recompression therapy in chambers. It is an emergency procedure, able to be applied with equipment usually found in remote localities and is designed to reduce the many hazards associated with the conventional underwater air treatments. The customary supportive and pharmacological adjuncts to the treatment of recompression sickness are in no way avoided, and the superiority of experienced personnel and comprehensive hyperbaric facilities, is not being challenged. The underwater oxygen treatment is considered as a first aid regime, not superior to portable recompression chambers, but sometimes surprisingly effective and rarely, if every, detrimental.

Case Report

Because of the nature of this treatment being applied in remote localities, many cases are not well documented. Twenty-five cases were well supervised before this technique increased suddenly in popularity, perhaps due to the success it had achieved, and perhaps due to the marketing of the equipment by CIG (Medishield). Three more recent cases are now described.

Case 1

A 68 year old male salvage diver.

Two dives to 100 feet for 20 minutes each were performed with a surface interval of 1.5 hours - while searching for the wreck of the Pandora, about 100 miles from Thursday Island in the Torres Strait.

No decompression staging was possible allegedly because of the increasing attentions of a tiger shark. A few minutes after surfacing, the diver developed paraesthesia, back pain, progressively increasing inco-ordination and paresis of the lower limbs.

Two attempts at underwater air recompression were unsuccessful when the diving boat returned to its base mooring. Symptoms were worrying and the National Marine Operations Centre was finally contacted for assistance.

It was 36 hours, post dive, before the patient was finally flown to the regional hospital on Thursday Island. Both the Air Force and the Navy had been involved i the organisation, but because of very hazardous air and sea conditions, and very primitive air strip facilities, another 12 hours would be required before the patient could have reached an established recompression centre (distance 2000 miles).

On examination at Thursday Island, the patient was unable to walk, having evidence of both cerebral and spinal involvement. He had marked ataxia, slow slurred speech, intention tremor, severe back pain, generalised weakness, difficulty in micturition, severe weakness of lower limbs with impaired sensation, increased tendon reflexes and equivocal plantar responses.

Because of the involvement with pearl divers, an underwater oxygen unit was available on Thursday Island, and the patient was immersed to 8 metres depth (the maximum depth off the wharf). Two hours were allowed at that lesser depth and the patient was then decompressed. There was total remission of all symptoms and signs, except for small areas of hypoaesthesia on both legs.

Case 2

23 year old female sports diver.

Diving with 72 cu ft SCUBA cylinder in the Solomon Islands. (Nearest recompression chamber is 2000 miles away and prompt air transport was unavailable). Dive depth was 110 feet and duration approximately 20 minutes, with 8 minutes decompression. Within 15 minutes of surfacing she developed respiratory distress, then numbness and paraesthesia, very severe headaches, involuntary extensor spasms, clouding of consciousness, muscular pains and weakness, pains in both knees and abdominal cramps. The involuntary extensor spasms recurred every ten minutes.

The patient was transferred to the hospital, where neurological decompression sickness was diagnosed, and she was given oxygen via a face mask for three hours without significant change. During that time an underwater oxygen unit was prepared and the patient was accompanied to a depth of 9 metres, in the bay. Within 15 minutes, she was much improved, and after 1 hour she was asymptomatic. Decompression at 12 minutes per metre was uneventful and the patient was subsequently flown by commercial aircraft to Brisbane.

Case 3

A 19 year old male trainee diver, under dubious instruction.

Depth approximately 150 feet duration 15 minutes. Twenty minutes after surfacing, he had the first of three epileptic convulsions, extending over a one hour period. Between convulsions there seemed no other evidence of decompression sickness other than mild back pain. There was no personal or family history of epilepsy.

A 9 metre oxygen treatment was given, without complication and without sequelae.

This is presented for discussion as it is an excellent example of the type of case that can be made complicated by the 60 foot oxygen therapy tables, when a convulsion during treatment can be attributed to either decompression sickness or oxygen toxicity. This would cause considerable management problems - especially if one is not sure of the original diagnosis! To subject such a patient to the deeper air tables may considerably hinder treatment if one's provisional diagnosis is wrong. Alternately to not recompress may result in further damage from decompression sickness or the perseverance of a potentially remedial epileptogenic focus.

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Is father unfair to his son?

Patricia Sneddon, blonde haired and ten years old, has earned her title of "Bubbles". She has been scuba diving for 18 months and swims in the Manly Marineland tank, mainly for fun. Apart from the sharks the pool contains a few gropers, stingrays, and turtles, as well as hundreds of small fish. She says that the sharks don't worry her (there is only one big male she won't pat, because he snaps), but the turtles are apt to bite fingers. Her father, who has been diving in the pool for a few years, organised her first dive after she pleaded for a go. "Her mother was worried stiff - when Bubbles first went in, but I know she is safe", he said. That was a year ago. "I love it. It's better than ordinary diving. And they wouldn't touch me: I'm a girl", she told and interviewer.

This happy-go-lucky schoolgirl is too young to dive for money, so she does it for experience, and to overcome school holiday boredom. Her younger brother Adam, aged 6 years, is considered to be still too young to dive, with or without sharks. But then everyone knows that fathers tend to spoil their daughters".

MD and SH, January 1979

APPENDIX

Comments of the Debates about the underwater oxygen treatment for DCS
Carl Edmonds

With the increased use of the underwater oxygen recompression treatment amongst non-medically trained divers, it was inevitable that some illogical and optimistic beliefs would develop. There is an equal, but opposite tendency amongst diving medical physicians, to invoke critical comments on practices with which they have not been associated. Both attitudes are understandable in view of the sometimes extreme personal and emotional involvement in this sport. The diver working in remote localities, has a desperate need for recompression facilities, and he may hopefully see the underwater oxygen decompression unit as the answer to all his problems. Likewise, the diving physician who works in an elaborate hyperbaric facility would see no real value, when this simple unit is compared to his own, for more sophisticated facilities. An attempt will now be made to answer some of the claims that have been made by divers and diving physicians - or which have been attributable to them, perhaps incorrectly.

1. Inappropriate Cases for Treatment

It was originally hoped that the treatment regime would be sufficient for treating minor cases of decompression sickness and prevent deterioration of more severe cases whilst suitable transport was being arranged. It was presumed that the treatment would not be successful in treating these severe cases per se, and that it would not be applicable to patients who had any degree of clouding of consciousness, or who were unco-operative.

A change of pattern has developed, and some patients have been subjected to underwater oxygen recompression, when they previously would not have been considered as suitable candidates. Although it is not recommended, semi-conscious patients certainly have been recompressed in the water, using these techniques. The other modification of the original attitude, has resulted from the observations that, for both the very recent case and for the very long standing case, there is often dramatic improvement even though classified as type 2, or severe decompression sickness.

It is commonly observed that improvement continues throughout ascent at 12 minutes per metre. Presumably the resolution of the bubble is more rapid at this ascent rate, than the expansion due to Boyle’s Law. This is also consistent with our knowledge of treatment of saturation DCS cases. Some cases which did not respond adequately at the maximum depth of 9 metres, subsequently responded during the decompression procedure.

Despite the above comments, there is no doubt that the underwater oxygen recompression treatment is not applicable to all cases, and especially when the patient is unable or unwilling to return to the underwater environment in safety. It is also of very little value in the cases where gross decompression staging has been omitted, or where disseminated intravascular coagulation syndrome has supervened. I would personally be reluctant to administer this regime when the patient has either epileptic convulsions of clouding of consciousness. Reference to the case reports reveal that others are less conservative.

2. Oxygen Toxicity

Fear of oxygen convulsions or respiratory oxygen toxicity, especially in the underwater environment, would be valid if the conventional oxygen therapy tables were used. In the latter case there would also be considerable difficulty in alternating the air breathing periods with the oxygen, underwater. To omit the air breathing periods of these tables would greatly increase the likelihood of oxygen toxicity. Such is not the case with the techniques described here. The maximum depth of 9 metres ensures that oxygen convulsions are most unlikely to develop. Significant respiratory oxygen toxicity is also most unlikely at this pressure and duration. It is however, recommended that once the person has reached the surface, both chest x-ray and lung function measurements should be performed routinely - while intermittent oxygen is utilised to reduce the likelihood of recurrence of symptoms. Fear of oxygen toxicity is more common amongst non-medically trained personnel, who often are not aware of the safety margin for oxygen toxicity.

The use of oxygen on the surface, to reduce the recurrence or progression of decompression sickness, does entail some risks. It is essential that the attendants under these conditions are very aware of the problems with oxygen and the danger of fire. It is also important they understand the value of a close fitting face mask. In many cases divers feel more at ease when breathing through a demand valve system, similar to their conventional amateur SCUBA apparatus.

3. Emergency Termination of Treatment

This is s a very valid and very common worry for those patients and attendants undergoing underwater air recompression treatment. There are many causes for this termination, and they range from environmental and operational to clinical and psychological causes. When planned decompression stops have to be omitted, both the patient and the attendant can be affected by decompression sickness due to the extra underwater exposure increasing some of the tissue nitrogen levels. Such is not the case if oxygen is used underwater. The denitrogenation associated with the hyperbaric oxygen breathing will be more likely to reduce the bubble size and improve the clinical state of the patient.

Fortunately the depth of 9 metres ensures that the attendant, irrespective of his previous diving exposure, will be unlikely to develop any symptoms of decompression sickness, even if the treatment has to be aborted at any stage.

4. Hypothermia

One of the common comments in Australia is that this underwater treatment regime is very applicable to the semi-tropical and tropical areas (where it was first used), but not applicable to the southern parts of the continent, where water temperatures may be as low as 5-10°C. There are certain inconsistencies with this statement. Firstly, if the diver has become ‘bent’ while diving in these waters, then he is most likely to already have excellent thermal protection suits available to him. Also, the duration underwater for oxygen treatment is not excessive, and it is at a depth at which his wet-suit is far more functional than at his maximum diving depth. If he is wearing a dry suit, the argument is every less applicable.

As a general rule, it is probable that the conditions for underwater oxygen recompression treatment will be far less likely to produce hypothermia than the conditions under which the patient developed his decompression sickness. If the alternative is underwater air treatment, then the depth, duration and hypothermia stress exceeds those of the underwater oxygen.

5. Adequacy of Equipment in Remote Areas

This is a very valid doubt. Fortunately in most areas there are cylinders of oxygen (for medical and first aid reasons), and the main problem is in obtaining a high pressure hose connected to a demand valve, suitable for the patient's use. These problems are not usually beyond the capability of the local divers in combination with the hospital or first aid station. Various emergency modifications have had to be used in the past. These have employed industrial oxygen instead of medical oxygen, SCUBA cylinders filled with oxygen, medical high pressure hose replacing underwater hose, etc. The availability of appropriate equipment for this treatment has been improved by Commonwealth Industrial Gases (Medishield), Australia, supplying a packaged unit that divers take with them when they visit and dive in remote areas. This unit still required the addition of an oxygen cylinder to make it functional. It is also of value in the treatment of drowning cases, who require intermittent positive pressure oxygen respiration over prolonged periods.

The facilities for underwater air recompression therapy are also less than adequate in most situations. Nevertheless, there may be conditions in which compressed air is readily available, and when there may not be sufficient oxygen. Under these conditions the efficiency of one treatment must be weighed against the other, or a combination of both be improvised.

6. Seasickness

This common malady has been the cause of many problems in the treatment of decompression sickness using compressed air underwater. The main reason is the greater depth required for compressed air treatment, thereby necessitating a return of the diver to the open ocean. This is likely to cause severe seasickness, in both the diver and the attendant, and is well understood by any diver who has undergone decompression staging in the ocean, tethered to a boat. The time factor for air treatment is much longer than that for the customary decompression staging from an uneventful dive and the likelihood of seasickness is proportionately greater, resulting in premature termination of the treatment.

With the underwater oxygen regime, a maximum depth of 9 metres is required and this can usually be achieved in either sheltered inlets, bays or even off the end of the wharf.

7. Operator Expertise and Training

This is a necessity when one is utilising a recompression chamber, where fire and explosion must be seriously considered hazards, together with the other operational difficulties well known to hyperbaric personnel. Expertise would also be required if there were to be a change of gases, eg. from air to oxygen or vice versa, as in the case of the conventional oxygen tables, if they were transposed unchanged from the recompression chamber to the underwater environment, this has been proposed by Italian workers. Some degree of operator expertise is also required in the underwater air treatment, when cylinders have to be changed without surfacing the divers, or where compressors have to be maintained.

There is very little operator knowledge or training needed when using the underwater oxygen regime. The equipment requires only that the operator screw the regulator into the oxygen cylinder, fit the full face mask onto the diver's head and follow the tables as described on the unit. There is very little that can go wrong. The hose is of a length insufficient to allow the diver to be exposed to neurological toxicity with oxygen. Oxygen does not escape into the surrounding boat area, and therefore there is no serious problem from accidental fire or explosion. In the event of Murphy's Law applying, and somehow or other the treatment being terminated, neither the patient nor the attendant are in danger of aggravating decompression sickness. Thus there seems to be many fewer problems with the underwater oxygen treatment than with the alternatives.

8. Safety of the Diving Attendant and the Boat Tenders.

Mainly because of the shallow depth required for the underwater oxygen treatment, both the boat crew and the divers are less likely to be exposed to serious environmental hazards. The diving attendant is not subjected to the likelihood of nitrogen narcosis, decompression sickness or hypothermia. Each one of these dangers may accompany the underwater air treatment. The dangers which are associated with hyperbaric chamber operation are also not present, and the boat tenders do not require to return to the depths necessary for underwater treatments - these usually imply and open ocean exposure.

9. Requirement for Medical Supervision

Occasionally one hears that the treatment should only be used when a physician is available to supervise it. This does not seem either relevant or practical, in my opinion. It certainly was so in early days, when it was an experimental procedure, performed with some trepidation. There is little that a physician would be able to do to either improve or facilitate the underwater oxygen treatment regime. He would certainly be of value in the initial assessment of the case, and for its subsequent management.

10. Transport Availability

Some claim that the underwater oxygen treatment is more value when there are no transport facilities available. Initially this was also our own teaching, but with the logic that comes from hindsight, one only needs a 3 hour gap between the instituting of underwater oxygen treatment and the arrival of transport, to be able to utilise this system. It is probably just as important to treat the serious cases early, even though one may not get full recovery, than to do nothing and watch the symptoms progress during these hours.

There is no doubt, especially in serious cases, transport should be sought while the underwater treatment is being utilised.

11. Misuse of Equipment

It has been stated that if this equipment is available for treatment of decompression sickness cases, other divers may well misuse it, decompression on oxygen underwater, and perhaps running into subsequent problems. This is more an argument in favour of educating divers, than depriving them of potentially valuable treatment facilities. An analogous argument can be used to not promote good diving equipment on the grounds that it may increase the extent of diving! Carried to the logical extremity, one could well use this type of argument to totally prohibit all types of diving equipment, including recompression chambers, and thereby hope to circumvent all diving related problems.

12. Pulmonary Barotrauma Cases

It has been argued that this treatment is unlikely to be of any value for those patients suffering from air embolism. Such may well be the case. The treatment was never proposed for this, and nor was it ever suggested that the underwater oxygen treatment be used in preference to recompression facilities where they exist, or where they can be obtained. It is, however, possible that the treatment may be of value for those cases of mediastinal emphysema, and perhaps even a small pneumothorax.

The Girl with Everything: A diving incident

Martin J Nemiroff, MD
Assistant Professor of Internal Medicine
Pulmonary Division, University of Michigan Medical School

I would like to report a combination of cold water mishap/scuba accident that may be of interest to readers of the SPUMS Journal.

The patient is a twenty-five year old female who was diving in a sunken wreck, in 60-120 feet of water, in the Straits of Mackinaw north of Michigan's lower peninsular. She was at a depth of 60 feet, on the wreck when she lost her two companions, struggled with a loose weight belt, and then found herself lost inside the wreck. The water temperature was 40°F and by this time visibility was near zero because of te stirred-up silt. She breathed the last of her air and with very little panic began to breath water, resigning herself to die. She then lost consciousness. Her diving companions surfaced and did not find her on board the surface vessel. Only one had air remaining and began a search. He found the victim face down in a stateroom with mouthpiece out and brought her to the surface in an emergency ascent (much faster than 60 feet/minute). Once at the surface CPR was begun expertly as both diving companions were CPR instructors. The patient regained consciousness enroute but remained cyanotic, cool to the touch, and "not herself". Pulse and respiration had returned within two minutes of surfacing.

US Coast Guard assistance arrived and transported the victim to the recompression chamber two hours away using pressurised fixed wing aircraft. On arrival the patient was semiconscious, blue and breathing with difficulty. She complained of increasingly severe abdominal pain and shortness of breath. Examination showed no subcutaneous emphysema although there were previous reports of this. She had diffuse rales, rhonchi and wheezes universally. A Hammans sign was present over the heart. The abdomen was tender to palpate and there were no audible bowel sounds. Her admission chest x-ray showed acute pulmonary oedema. EKG showed non specific T wave changes. She was recompressed using US Navy Table 6, with complete resolution of abdominal pain and improved respiratory function. During pressurisation she turned pink and mentation became normal, though she was much troubled by coughing massive amounts of pink frothy pulmonary oedema fluid. On examination there was reduction of the rales, rhonchi and bronchospasm.

She recovered entirely within one week and was discharged from the hospital. it was learned that she had asthma before the accident and the initial physical examination had revealed diffuse wheezing. She was advised not to scuba-dive again, advice she reluctantly agreed to follow.

One question asked of our team was why recompress to only 60 feet (US Navy Table 6). I would have preferred 165 feet (US Navy Table 6A), but the patient had intolerable ear discomfort and her symptoms were already improving at 60 feet.

This patient had a ten minute airless period in 40°F water, was found, and was brought to the surface in a head tilted upward rapid ascent. She owes her life to the skilled action of her diving companions and the other personnel, full recovery being obtained. Our impression is that she suffered from:

Freshwater near drowning
Cold water submersion
Decompression sickness
pulmonary barotrauma , suspected air embolism
Status post cardiopulmonary arrest

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Addendum

The following extract from *Sea Secrets*, Nov-Dec 1978, the International Oceanographic Foundation publication, is reprinted by kind permission. It is highly relevant to the above incident.

QUESTION: Is it true that a person who appears to have drowned in water may not actually be dead?

ANSWER: The results of a Sea Grant project carried out by Dr Martin J Nemiroff at the University of Michigan showed that people who have "drowned" in cold water 70°F or below) are not necessarily dead, even if they have been underwater for as long as 30 minutes. A number of such victims have lived, and Nemiroff believes that what saved them was the activation, after their faces were submerged, of an automatic response in mammals called the mammalian diving reflex, combined with the coldness of the water. The reflex allows sea-going mammals to exist and function underwater without breathing for up to 30 minutes. It reduces the blood supply to the skin, muscles, and other tissues which are resistant to oxygen-loss damage, and reserves the remaining blood oxygen for the brain. Cold water also reduces the oxygen need of the tissues, further lengthening survival time without external oxygen. Rescue workers and doctors are advised not to give up easily on clod-water drowning victims. According to Nemiroff, he or she may be cold, blue, not breathing, have no detectable pulse or heartbeat, and fixed and dilated pupils, but the victim should not automatically be presumed dead. He recommends the following procedures: resuscitation should be started immediately. External heart massage and ventilation with as near 100% oxygen as is available should b given. The body should be warmed gradually from the inside by raising the temperature of the oxygen to 100°F with a humidifier. Resuscitation should be maintained at least until the body temperature reaches normal. Defibrillations (shocking the heart into action) may not be successful until normal body temperature is reached. (7.70 3431)

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No Comment section

The Official Sponsor of Victoria's Sport Personality of the Year contest is a firm of funeral directors.

(MD 9 November 1978)

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Memorandum No 4 1979
continued from page 40

It is the duty of the installation manager, the owner of the installation, and all persons on or near an installation to do nothing to endanger the safety of themselves or others.

Radiological Skeletal Survey for Aseptic necrosis of Bone in Divers and Compressed Air Workers

Notes prepared by the Medical Research Council Decompression Sickness Panel, United Kingdom
(Chairman: Professor DN Walder, MD)

Aseptic necrosis of bone is one of the health hazards of exposure to a hyperbaric environment such as diving or working in compressed air. The signs are the formation of lesions of dead bone in the head, neck or shaft of the major long bones. These lesions may remain symptomless but should they involve the articular surface of a major joint a painful and disabling osteoarthritis may result. The condition is also known as dysbaric osteoarthritis.

The precise cause of bone necrosis is not fully understood. Results of research indicate that an infarct of bone or bone marrow may result from exposure to, or decompression from, a high ambient pressure. This results in death of those bone cells deprived of their blood supply. Bone necrosis is not usually seen radiologically until revascularization of the necrotic area occurs. When this happens new bone is laid down upon the dead trabeculae, resulting in an absolute increase in the radiological density of the involved portion of the bone. A relative increase in the density of the avascular bone may sometimes be seen at an early stage when the surrounding healthy bone is the site of disuse osteoporosis. Radiologically it is not always possible to distinguish the stage of relative increase in density from that of the absolute increase in density.

Dense areas may be vague and ill defined or they may be distinct with a circular or irregular outline. They occur in the head, neck and proximal shaft of the humerus or femur and, most frequently, in the distal end of the femur and the proximal tibia. These are the skeletal areas routinely radiographed. Lesions have also been reported in the distal shafts of the humerus and tibia and in the fibula, but the elbow and ankle are not included in the recommended routine skeletal survey. Lesions may occur unilaterally, bilaterally or in any combination of sites. There is no set pattern. The articular surfaces of the knee joint are rarely, if ever, involved but the shoulder or hip joints may become disorganised through sequestration or collapse of the articular surface of the head of the humerus or femur.

The Medical Research Council support a Decompression Sickness Research Group which is carrying out research into the aetiology of aseptic necrosis of bone at the University of Newcastle upon Tyne. Part of this research involves the collection and review of large numbers of bone radiographs of divers and compressed air workers. The MRC Decompression Sickness Panel has prepared these recommendations to promote consistency in the radiographic examination for the detection of the disease.

British diving regulations require that commercial divers working on offshore installations or from diving barges in the North Sea and around Britain’s coast must undergo radiographic examination of their bones annually as a precondition of certification of fitness to dive. Similarly in the civil engineering industry, the accepted ‘Medical Recommendations for Work in Compressed Air’ advise that men who work at gauge pressure of 14 pounds per square inch (1 bar) or more should have their bones radiographed every six months whilst continuing so to work, followed by annual examination for at least two years after they cease to work at or above that pressure.

The Basic Radiographical Survey

The basic skeletal survey should include antero-posterior projection of the heads and proximal shafts of both humeri and both femora together with antero-posterior and lateral projections of the distal two thirds of both femora and proximal third of both tibiae including the knee joints.

The radiographic diagnosis of early lesions of aseptic bone necrosis requires high quality radiographs which demonstrate the bone trabeculae clearly. The optimum screen-film combination (using rare earth intensifying screens, if available) and good screen-film contact is required together with a grid of adequate ratio and a focal spot of 0.6 to 1.2mm. A tube with a high speed rotating anode and 0.6mm target, if available, is ideal.

Exposures should always be adequate. Probably the greatest fault lies in under penetration of the bone tissue. Increased penetration by as much as five to ten kilovolts above normal is recommended.

The recommendations of the “Code of Practice for the Protection of Persons against Ionizing Radiation arising from Medical and Dental Use” should be followed.

Gonads must always be protected by a lead shield when radiographing the hips. Estimation of the radiation dose received by the patient indicates that this basic survey can safely be repeated at intervals of not less than six months.

Recommended Procedure

Shoulder: Antero-posterior projection

The area to be examined is the head and neck of the humerus including the proximal third of the shaft. The radiograph should show the articular surface of the humeral head unobscured by overlying bony structures and should give good definition of the trabeculae of the head and shaft.

A 24cm x 18cm screen film is recommended with high definition or rare earth intensifying screens and a moving grid.

The examination is best carried out on a horizontal table. From the supine position the patient is rotated through about 45° towards the side under examination until the blade of the scapula is parallel to the table top. The raised shoulder is supported on sandbags.

The arm under examination should be straight, supinated and abducted 10°. An extending pull should be applied to the arm so that the humeral head is clear of the bony processes of the scapula.

The X-ray beam should be at right angles to the film and centred over the head of the humerus. The beam should be collimated to show only the head and proximal third of the humerus.

The patient should hold his breath whilst the exposure is made.

Hip Joint and Proximal Third of the Shaft of the Femur: Antero-posterior View

The radiograph should show good definition of the articular surface of the femoral head and of the trabeculae of both head and shaft. The underlying acetabulum cannot be avoided. A separate radiograph of each hip is required.

A 30cm x 24cm screen film is recommended with fast tungstate or rare earth intensifying screens and a moving grid. Fast tungstate screens are recommended in this situation to reduce the radiation dose. 2.5 to 5 Kilovolts more than normal should be used to increase penetration. The gonads must protected but care should be taken to ensure that the protection does not obscure the femoral head.

With the patient supine the plane across the anterior superior iliac spines should be horizontal. The foot of the side under examination should be at right angles to the table top and sandbagged into position.

The X-ray bean should be at right angles to the film, centred over the head of the femur, and collimated to show the head and proximal third of the femur.

<u>Knee joint: Antero-posterior projection to show the distal two thirds of the femur and the proximal third of the tibia</u>

The radiograph should show clear trabecular detail in the lower two thirds of the femur and the upper third of the tibia.

There is a variation of density between the middle and lower thirds of the femoral shaft so that it is necessary to increase the kilovoltage, reduce the milliamperage and use a moving grid to produce a radiograph of even contrast. Care should be taken not to under penetrate the shaft of the femur.

A 40cm x 15cm screen film is recommended with high definition or rare earth intensifying screens and a moving grid.

The patient should sit on the X-ray table with both legs extended. Each knee should be examined separately.

The X-ray beam should be at right angles to the table top. In order that the lower two thirds of the femur are included the beam should be centred at the upper border of the patella - not through the joint space. The beam should be collimated to show only the area under examination.

<u>Knee Joint: Lateral projection to show the distal two thirds of the femur and the proximal third of the tibia</u>

A lateral radiograph of the lower femur and upper tibia may demonstrate slight variations in bone density and trabeculae detail which are not apparent in the AP projection.

The requirements of definition are the same as for the AP. The graduation of density along the femoral shaft is also evident in the lateral projection and the exposure should be adjusted to give a radiograph of even contrast.

Either a 40cm x 30cm or a 40cm x 15cm screen film is recommended with high definition or rare earth intensifying screens and a moving grid.

Using the wide film, positioning should be as for a normal lateral projection of the knee with the knee flexed and the tibia parallel to the long axis of the film in order to include the distal two thirds of the femur.

The X-ray beam should be at right angles to the film and centred over the femur level with the upper border of the patella. The beam should be collimated to the area under examination.

BOOK REVIEW

Sharks and Other Ancestors
Wade Doak (Hodder and Stoughton, 1975)

This book concerns itself with far more than shark behaviour, for it is also about the motivations of a select group of people. They are all divers by either primary or secondary intent, the study of the marine world is being a major interest to them all. And central to everything in this book is that remarkable character Dr Walt Starck and his boat, the El Torito. This is not an unbiased book, it is wholeheartedly on the side of the “unspoilt” natives of the Pacific area and the iconoclastic approach to the accepted Scientific beliefs practised by these privileged to join the cruise of the El Torito. But few are likely to quarrel with the pieces of Philosophy that appear from time to time and make this far more than a straight report on a dive boat excursion.

Readers will find that a large number of matters of interest are mentioned. These include a description of the Electrolung, Walt Starck’s invention, and of several diving incidents that show the need to be lucky and skilled if one ignores the advised rules of safe diving! There is a report of a nude water ski episode that reveals the author’s unawareness of the dangers of such antics (healthwise), and an illustration of what can go wrong even when one is in a “wet” submarine. The absolutely delightful description of the native children brought up next to an in the water and completely at home in it playing “rackalung” will long remain with this reviewer. However the unifying theme throughout this book is that of Sharks and of Walt’s fancy wetsuit.

There is no denying the courage, and luck, of those who get interested in inspecting aggressive sharks. So full marks to Walt, and the others, for their work. Walt has a theory that a striped suit will have a visual effect that confuses and “frightens” sharks, an effect he repeatedly demonstrated while his conventionally suited colleagues had to hurriedly leave the water. He even took a shark rattle underwater on one test sequence and covered his striped suit with a black cape till the subjects of the experiment were approaching. When he revealed himself as Supersnake the sharks reacted as would a maiden lady faced with a “flasher” in a quiet lane. This was an extremely gratifying response as a bang-stick is poor protection against a shark that means business.

The book does not limit itself to sharks, which can apparently tolerate children in the water and then without anything unfortunate occurring, but reports some remarkable findings concerning fishes. Fishes, though accounted as simple stupid creatures, have individuality and learning ability. Could <u>you</u> learn to distinguish all the fish in your favourite dive area and know which were newcomers and which were aware of your “rights”? There is the tale of Sammy, a trusting fish, who was able to find his way back to his home territory after being moved 1.5 miles away and was welcomed back by his own females but was too excited to eat the food they offered. It does pay some males to be too long away from their females, however. Many of the *[illegible]* are polymorphic, starting as cleaner fish and then developing into females and ceasing this occupation. This is the height of the development unless the single male that “owns” the territory they use should die, when the most dominant female will change and become male. Perhaps Nature is trying to tell us something?

Quite early in the book Walt speaks his thoughts: “Really I think of science as an entertainment, a philosophy and the artform of our technological society. Only occasionally can it offer anything practical, yet on those relatively few achievements our whole civilisation is based. It you set out deliberately to make practical discoveries, the whole thing goes dead. The aesthetic and philosophic values of science must be of first importance .... It should be realised that every breakthrough and development in our civilisation came from people playing around. The fuckoffs *(sic)* made the breakthroughs: men playing intellectual games, with no serious aim. Man plays first, then discovers a practical value later. Practical applications of science are limited by the available technology. To find something new, you can't just seek after something useful. Even electronics ... radar originally came from people playing with electricity and having no practical applications in their minds. The spirit of innovation is essential ...

"In a reef community no one link is critical. It's a net rather than a chain. There are many overlaps. So if a species is in trouble others fill the gap. Ecologists are becoming increasingly aware of this. Today, man is going the opposite way, reducing diversity and producing less stable systems. Instead of producing a new strain of super rice vulnerable to super disaster we should be seeking locally adapted varieties."

Applied research, he notes, is really just pure research done too late. While inventors of death rays may disagree with this luxurious view of what life is all about, most will agree with the main thrust of the statement. And it can be applied to diving medicine, where morbidity provokes research into the physiology of man in the sea.

It is a book to read with care, and pleasure!

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Illustration Not Scanned

A Queensland Sea Wasp Incident

Dr D R Pushen

On 19 March 1977 at 3.10 pm this patient aged 6 and a half, presented to the Ingham Casualty Department with stings predominantly on her right leg but also on her right arm and left leg. These were purplish in appearance and had blistering over the other side of her right ankle. They had the characteristic laddering appearance of a Sea Wasp jelly fish sting.

Clinical Record

At 2.25 pm on the 19th March 1977 she was being towed through the water by both her hands by her aunt, in water about two or three feet deep. She began screaming and her Aunt noted that she had stings down her leg, so pulled her from the water. Her father was called and within ten to thirty seconds of her being dragged from the water he had poured a large amount of Methylated Spirits over her legs. The ambulance was called and she was taken to the Ingham Casualty Department.

On admission she was in great distress and was given IV Sea Wasp Antivenene one ampoule, IMI Morphine 5mg, IVI Phenergan 5mg and Solu-Cortef 500mg IV and was placed on quarter hourly observations of respiratory rate, blood pressure, pulse rate, and level of consciousness. All Urine samples were to be tested for blood.

The actual stings of the sea wasp were removed from the wounds in the Casualty department after the patient had been sedated and washed down with more Methylated Spirits. These were not sent off to the laboratory but a positive “sea wasp” identification was made by Life Savers at Allingham beach who netted the area after the sting occurred.

At 4.15 pm it was noted that her colour was quite cyanosed. On examination her chest was clear, but she was difficult to rouse. She was then given THA 5mg IMI plus 5mg IV. Her colour then improved as her respirations increased. She continued on IV Solu-Cortef 500mg fourth hourly and IV Dextro 3.5% six hourly, and Synalar 0.01% ointment was applied to the sting welts.

On the 20th March she was put on Phenergan 5ml orally four times a day, Panadol 5ml fourth hourly, PVK 5ml four times a day and the IV Hydro-Cortisone 10mg fourth hourly.

On 21st March the patient continued doing well and the skin lesions appeared to be healing well except for a large area of blistering around her right ankle. She was put on Condy’s Crystals compresses third hourly (but not at night), and the Prednisone was reduced to 5mg four times per day. She was continued on Phergan *(sic)* 5ml four times daily.

From the 28th March the Prednisone was reduced by 5mg daily till it ceased. Following this her only treatment was Potassium Permanganate solution baths four times a day: she was discharged on this plus Phenergan 5ml three times daily.

On the 4th April the scars had decreased a great deal, with the worst area being around her right ankle where she had had the blistering.

The time of the incident is noteworthy as it was 19 days past the official end of the season for sea wasp stings. This may indicate that sea wasps do not have an ability to read calendars, or maybe we don’t know as much about them as we thought.

THE AGING DIVER: DO THE OLDER BECOME BOLDER?

LCdr Robert J Biersner, MSc, USN, Naval Submarine Medical Research Laboratory
Lt Mark L Dembert, MC, USNR, USS Grayback (SS-574)
ENS Mark D Browning, MC, USNR, National Naval Medical Center

> *"Research shows that young divers don't necessarily become old divers, and that the two groups do different types of diving."*

Background

Not much is known about the medical, psychological, and performance effects of aging among US Navy divers. The possibility has been raised that several medical consequences of diving, especially decompression sickness and osteonecrosis, may be complications of the aging process.[1,2] Both decompression sickness and osteonecrosis have been found to occur more frequently among older divers than among younger divers.1,2 The possibility exists however, that older divers may develop these adverse medical effects because they may make deeper, longer dives than younger divers. Such dives are known to result in a higher incidence of decompression sickness,[1,3] which in turn may lead to other medical complications such as osteonecrosis.[2] The only available data on this topic show a slight relationship between age and deeper, longer diving; but this relationship is not statistically significant.[3]

Approach

To obtain more detailed information on the effects of ageing, data were collected on a group of 52 divers (both Divers First and Second Class) who were stationed in the New London, Connecticut area. They were asked to complete questionnaires about pre-service history (size of hometown, delinquency problems, age of enlistment, etc), service and diving history (awards and recognition for diving performance, serving as an experimental subject or testing diving equipment, years of diving experience, number of diving accidents, disciplinary actions, etc), General Classification Test (GCT) scores, age, martial status, and the Cornell Medical Index (CMI). The CMI is a list of 200 physical and psychological symptoms or problems, and the divers were asked to circle any symptoms that they had experienced in the past.

Diving performance was assessed using diving records maintained at the Naval Safety Center. Diving records covering the 5 year period from 1972 to 1976 were obtained, and the following information was extracted: Total number of dives, number of dives over 50 fsw, number of dives at surface temperatures of 40°F or less, and number of night dives. These four diving categories are measures of exceptional diving activity, either because these dives are physically or psychologically discomforting, or because these conditions are associated with frequent diving accidents.[1,3] The total number of dives in each of these four categories was then divided by the number of years each diver had been active in diving during this 5 year period. This correction provided a common basis for comparison. In addition the medical records of each diver were reviewed and the number of sick calls made for each year of diving experience over this 5 year period was documented. Care was taken to avoid counting repeated visits for the same disease or injury. Treatments for decompression sickness and routine physical examinations were also excluded from this tally.

The 52 divers were divided into three groups of nearly equal size according to age. To avoid the ambiguous and mixed results that could be associated with the middle section, which consisted of 17 divers between the ages of 26 and 32 years old, the group was dropped from the analysis. Only the youngest and oldest groups were compared. The youngest group contained 18 divers who ranged in age from 19 to 25 years of age. The oldest group consisted of 17 divers who were between 33 and 40 years old.

Findings

The average scores in each of the major diving categories are shown in Table 1. A statistical analysis of these results showed that the younger divers made significantly more dives and had more accidents per year of diving than did the older divers.[4] Commensurate with the higher frequency of diving accidents, the younger divers also tended to make more sick calls per year of diving than did the older divers. This difference in sick calls was not, however, statistically significant. Also, the difference between younger and older divers in the number of dives made over 50 fsw was nearly significant (with the younger group diving deeper).[5] The older divers, however, made significantly more night dives per year than the younger group. Although the results in Table 1 seem to show that the younger divers made more dives at cold surface temperatures than the older divers, the variability within each group for this type of diving made this difference insignificant. (Within the younger group, the number of dives at cold temperatures ranged from 0 to 42.5 per year, while for the older group this range was from 0 to 7.3.)

Although the finding that older divers have more years of diving experience than the younger group is not surprising, the difference in the years of service they had before they became divers was unexpected. This finding seems to argue that divers in the older age group wait a number of years after joining the Navy before qualifying in diving, while younger divers became diving qualified during the first enlistment. Older divers, however, remain qualified longer while younger divers appear to attrite from diving much earlier. This interpretation is supported by the small percentage of the older group who became divers during first enlistment (approximately 12%) compared to the younger group (100%), as well as the difference in total years of diving experience between the two groups.

In addition to the aforementioned findings, further comparisons showed that the two groups did not differ significantly from each other in verbal intelligence (GCT scores), self-reported medical problems (CMI scores), pre-Navy delinquency problems (truancies, high school disenrollment, traffic violations, and arrests for non-traffic crimes), Navy disciplinary actions (masts, reduction in rate, failure to obtain good conduct awards, and disenrollment from Navy schools), and special diving recognitions (awards for diving and participating as an experimental subject or testing diving equipment). These last two measures - Navy disciplinary actions and special diving recognition - were adjusted or divided by the total years of Naval service and total years of diving experience in order to make the comparisons more valid).

Implications

If the previous 5 years of diving experience for those divers who were stationed last year in the New London area can be taken as representative of US Navy divers as a whole, then some important implications for US Navy diving can be deduced from these findings. Contrary to previous assumptions, older divers do not make more hazardous or arduous dives than younger divers. Younger divers do substantially more diving than older divers, and also do more diving to deeper depths. The only exception is night diving, which is more frequent for older divers compared to the younger group. The rationale for this exception is unknown. Perhaps diving supervisors believe that older divers will remain better oriented during night dives than younger divers. Or, perhaps the type of tasks to be performed at night (such as emergency search and rescue) are assigned to the older group because they may have more experience with or knowledge about the equipment to be salvaged. Another reason might be that they may be more familiar with the local geography.

The more frequent diving accidents reported by the younger divers are probably related to a combination of the more frequent and deeper diving than they do, as well as to inexperience. Decompression sickness was rare among both these groups (two cases in each group). Thus, not much can be said directly about decompression sickness and the possible complications of decompression sickness (such as osteonecrosis) for these groups. Most of these self-reported accidents involved stings, bites, squeezes, and trauma (such as cuts, sprains, and bruises). These types of accidents are related largely to environmental conditions and to the tasks that are performed, thereby involving a combination of heightened exposure to danger (which may be largely unavoidable) and task familiarity (which may be improved through better training or experience).

This situation, in which younger divers appear to be diving more frequently under more dangerous conditions and experiencing more accidents than older divers, may account for the finding that few of these younger divers last long enough to become members of the older group. They appear to join the diving ranks earlier (perhaps on impulse), volunteer for or are assigned to the more difficult diving situations, and then attrite more quickly from diving than the older group. Waiting as they do until after the first enlistment to volunteer for training older divers appear to be more cautious about becoming divers and may be more career-motivated than younger divers. Once qualified, they seem to have adopted a slower, more conservative diving pace than younger divers (at least as they grew older). As a result, older divers are more durable and suffered fewer ill effects from diving than younger divers.

These results, however, do not say much about what the older divers were like as young divers. Did they, too make more dangerous dives? If so, they may have remained in diving because of some motivational or personality difference between them and their peers? If, on the other hand, they did not differ much psychologically from their peers, then perhaps they were simply lucky and did not experience many of the fatiguing or dangerous diving conditions that their peers did (or at least not as often). Perhaps the difference lies in some combination of luck and psychology. Until more information is forthcoming, these results seem to be described best by paraphrasing the old adage, “There are old divers and there are bold divers, but there aren’t many old, bold divers.”
As stated earlier, the question remains unanswered about the extent to which the diving activity of these two groups is voluntary or the result of differential supervision. Perhaps younger divers are routinely sent to diving billets that involve making more numerous and hazardous dives. An answer to this question would provide a better understanding of the psychological dynamics of the two groups and of the accelerated attrition that is occurring among younger divers.

These findings also indicate that the higher incidence of decompression sickness; and osteonecrosis found among older divers does not appear to be related to more frequent exposure to deeper, longer dives. The higher incidence of decompression sickness (and other medical complications associated with decompression sickness) found among older divers would appear, therefore, to be related to some biochemical or physiological effect of the aging process. This interpretation should, however, be validated on a much larger group of older divers who have had more decompression sickness.

Acknowledgements

The authors wish to thank the divers and diving supervisors in the New London area who co-operated in completing the questionnaires, and the Deep Sea Diving Medical Technicians who made health records available. The assistance of the Naval Safety Center, especially CDR William Mullaley of the Submarine Safety Division, in providing diving records is most appreciated.

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4. For those who are interested, significance was determined using t-tests for independent samples. A significant "t" is equal to at least 2.040 (at 33 degrees of freedom). "Significant" means that the probability that these differences occurred by chance is equal to or less than 5 in 100 (two-tailed test).

5. "T" was equal to 1,950; chance was therefore between 5 and 10 in 100.

continued on page 57

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An unusual frostbite victim

Susie Wong has had rather too much of the English winter it seems, and is now on her way to Hong King despite a series of misadventures sufficient to deter the most independent of travellers. In the first place Susie, a 4 metre killer whale, had to leave her Clackton Wildlife Park pool on New Year's day when heavy seas and gales threatened to crack it and release her into the cold North Sea. She was packed into a giant metal cage (she weighs 2.5 tonnes!) swathed in wet blankets and had her head rubbed with a special grease to keep it moist during the journey to the airport. However the freezing temperatures dried the grease and she began to suffer, so the attendants stopped the truck and hosed her down till she recovered. Then they discovered that the truck's diesel fuel had frozen. In the end they reached the airport three hours too late for the plane. It is reported that she suffered no permanent damage from the frostbite and is getting over the experience. The public rarely gives a thought to the tribulations of their entertainers. But that' Sho Business!

Diving Safety Memoranda
Cmdr SA Warner, Chief Inspector of Diving,
Department of Energy, Production Engineering Division, UK.

MEMORANDUM NO 23, 1978

Diving near culverts, other inlets and pipelines

It is necessary, once again, to draw the attention of diving companies and associated engineers to the dangers involved when divers are operating in the vicinity of installations or equipment that control or can produce sudden flow of water or differential pressures.

Before commencing diving operations in the vicinity of docks, locks, basins, sea chests, or pipelines adequate steps must be taken to ensure that divers will not be exposed to any sudden flow of water or differential pressure. It is essential that the following basic precautions are strictly observed:

(a) ascertain the positions of culverts, inlets, pipe ends, etc. which could in the event of penstocks, sluice valves, or valves being operated, endanger the divers.
(b) Ensure that the authorities in charge of persons in a position to operate such valves are fully informed of the area and time of any diving operations, and of the possible dangers to divers.
(c) Before any valve is operated, the operation of which would constitute a risk to the divers, all divers are to be out of the water.

Attention is drawn to the Offshore Installations (Diving Operations) Regulations 1974, the Merchant Shipping (Diving Operations) Regulations 1975 and the Submarine Pipelines (Diving Operations) 1976 all of which state that masters of vessels and installation managers shall ensure that no operations or activities which might be a danger to any person engaged in those diving operations are carried on from or on the vessel or installation and to consult the diving supervisor about those operations or activities before the commencement of diving operations. It is also the responsibility of the diving supervisor to consult with the manager of an offshore installation or the master of the vessel to ensure that divers are not put at risk by other operations or activities.

“Attention is also drawn to the Diving Operations Special Regulations 1960 and appropriate parts of Construction Regulations both of which apply to certain activities within the scope of the Factories Act, 1961. Regulations 6 of the Construction (Working Places) Regulations 1966, which deals with the safety of working places and the access and egress associated with them, is particularly relevant to many of the situations envisaged above.

“All diving work inside Great Britain (including inshore waters) is subject to additional requirements in the Health and Safety at Work etc. Act 1974 which places specific duties to ensure the safety of all persons at work not only on employers (section 2) but also on self-employed (section 3) and those who have control of working places (section 4)”

“Serious hazards to divers can also be created due to pipelines, valve gear or similar plant under an external head of water being damaged. It is essential that all such plant is constructed and installed to a high standard and that adequate steps are taken to prevent it from being damaged by natural forces or mechanical or other devices”.

MEMORANDUM NO 2, 1979

Divers operating from a dynamically positioned vessel

The attention of all diving companies and Masters of vessels carrying divers is drawn to the inherent dangers of operating divers from a dynamically positioned vessel especially in the close vicinity of structures and underwater obstructions.

A research project has been initiated aimed at producing advice on the safety parameters to be employed when using this technique.

MEMORANDUM NO 3, 1979

Diving Bell sealing doors

Discussions with the industry suggests that some companies are removing the bottom sealing doors from their diving bells when operating in the saturation mode. This habit may be acceptable when the saturation storage depth is that of the maximum depth of water.

With increased diving activities involved in “inspection and maintenance”, much of which is carried out using the saturation diving technique but with a storage depth considerably above sea bottom depth it introduces a potential hazard.

At least 3 diving bells were dropped in the North Sea Sector during 1978.

Whenever diving is conducted from a diving bell using mid-water diving techniques and the maximum water depth exceeds the internal bell pressure by more than 1 ATA, bell external and internal pressure tight seals should be shut and secured before lifting the bell to the surface.

MEMORANDUM NO 4, 1979

Sea bottom debris/danger to divers

The attention of all concession owners, offshore installation owners, diving companies and offshore installation managers is drawn to the potential danger involved with operating divers on a foul bottom.

Diver’s experience offshore indicates that as a result of a build up of “rubbish/debris” thrown overboard from platforms or supply vessels, the dangers to divers and underwater vehicles is being made progressively worse. This danger can be aggravated by tide and current conditions.

A recent diver’s report of sea bottom conditions around a platform showed the presence of: a portacabin, generators, wires, cordage, scaffold tubing, prefabricated steel parts, rubber hoses, fishing nets, fishing lines and hooks and polythene bags. The “foul bottom” problem is inherent with fixed platforms and becomes progressively worse with the age of the platform.

Fishing is an obvious and attractive spare time activity on offshore installations. However, the loss of bottom gear consisting of hooks and lines, many of the lines being extremely high breaking strain and virtually indestructible, presents an increasing potential danger to divers and submersibles.

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Keeping the Diver Warm!

This article is reprinted from *FACEPLATE* (Summer 1978) by kind permission.

Adequate thermal protection is essential whether one is diving in frigid or warm water. While wet suits, as shown here are still used in cold water operations, they lose much of their thermal protection value when compressed at depth. The thermal protection system being, developed by NCSC is designed around the dry suit concept, with specialized accessories and a layered undergarment that is compression-resistant.

> *Cold is the source of more suffering to all animal nature than hunger, thirst, sickness, and all other pains of life and of death itself put together.*
>
> *Thomas Jefferson*

Inadequate thermal protection is the single most limiting factor for the Navy diver. Moreover, much of the Navy's diving is conducted in cold water, and in situations which preclude surface support and restrict use of fully protective equipment.

The US Navy Diving Manual is clear on the subject of cold:

"As the diver's body temperature is reduced, he will first feel uncomfortable and then ... he will begin to shiver. If cooling continues, his ability to perform useful work may become seriously impaired. The hands lose dexterity and the sense of touch is dulled. As shivering intensifies, it brings on a general lack of coordination ... it becomes increasingly difficult to concentrate, and the ability to think clearly is soon lost. At extremely low temperatures, or with prolonged immersion, body heat loss will reach a point at which death will occur."

But the manual goes on to say that "appropriate dress can greatly reduce the effects of heat loss, and a diver with proper dress can work in very cold water for reasonable periods of time."

Which is what the Diver Thermal Protection (DTP) program at the Naval Coastal Systems Center (NCSC) is all about development and testing of "appropriate dress" to provide the diver with the best thermal insulation possible, and extend the length of time he can perform useful work in cold water.

Genesis of the Program

To do this, the DTP researchers first defined the operational requirements of Navy diving. There included diving modes and depths, mission characteristics, work requirements, dive duration and expected temperature ranges. Meanwhile, a panel of experts on thermal problems convened by BUMED developed a matrix of temperature limits for allowable thermal stress - for example, mean skin temperature must not drop below 77°F.

Using these criteria, NCSC launched a test program designed to evaluate commercial diving suit systems. The basic segments of this program are:

+ Evaluation of suit design and construction by textile engineers at the Navy Clothing and Textile Research Facility.
+ Anthropometric measurements by the Department of Kinesiology at UCLA to determine the range of motion afforded by seven suits.
+ Testing of insulative effectiveness of dry suits at the Army Research Institute for Environmental Medicine using the copper manikin technique.

+ Testing of insulative properties of various suit and undergarment combinations under wet, hyperbaric conditions using the copper manikin (see article on Meet “The Copper Man”)
+ Thermal studies on divers over a range of hyperbaric conditions in selected garment systems, in cooperation with NEDU.
+ Manned tests under simulated mission conditions.
+ Evaluation of gloves and other component equipment, including a joint NCSC/ NEDU program to measure hand and finger dexterity in cold water.

Toward a Basic DTP System

But the prime objective of the DTP program is the development of a basic thermal protection system. To this end, work is currently focused on dry diving suits, with special attention toward:

+ Improving seals and closures.
+ Selection of a good material for the outer garment.
+ Provisions for the containment of urine.
+ Provisions for the absorption of perspiration.
+ Development of an effective undergarment.

The system now being developed incorporates the above items. It is composed of an elastomer-coated fabric which has improved neck seals, wrist seals and entry closure. The undergarment (see accompanying article) is multi-layered and will withstand hydrostatic compression in the diver’s feet and leg regions. A diver urine collection system is being modified from a NASA-developed unit. The new suit system also includes inflation and deflation valves, integrated weight distribution, and dry gloves.

Diver Heater Approaches

NCSC is also developing diver heating systems for use in situations where the practical limit of passive thermal insulation systems has been reached. These active heating systems furnish heated water to the diver. Current approaches include:

+ A propane catalytic heater for the surface-supported diver.
+ A magnesium-oxygen system which burns magnesium wool in oxygen, for the free-swimming diver.
+ A hydraulically-powered system which circulates heated seawater to a PTC and diver at depth. It may also provide improvements over the existing hot water system in efficiency, and a reduction in hose losses and deck space requirements.

A more detailed account of the Diver Thermal Protection program at NCSC can be found in the 1978 Working Diver proceedings available from Battelle Memorial Institute, Columbus, Ohio. The article is titled, “Development and Test of Thermal Protection Systems for the Navy Diver,” by Maxwell W Lippitt.

* * * * * * * * * *

David Niven recently saw the film JAWS. The next morning while swimming in the motel pool he spotted a black form lurking under the water. “I was was walking on the water to get out. Then I found it was a maintenance man in a scuba suit fixing the drain,” he said.

(Australian, 16 March 1976)

Anatomy of an Undergarment

NCSC has developed a layered undergarment that is Comfortable, Moisture Absorbent, Compression Resistant at depth, and provides the Dry-Suited Diver with Excellent thermal insulation.

The basic thermal protection of NCSC's new dry suit system will be provided by an undergarment capable of withstanding the compression produced by hydrostatic forces from the chest area to the feet. The undergarment, which is being developed jointly by NCSC and the Naval Clothing and Textile Research Facility, is a composite with a comfort liner next to the diver's skin. A moisture-absorbing layer to contain any sweat produced at higher metabolic rates is applied next.

This layer is followed by a vapour barrier to prevent water vapour from passing through the insulation and condensing on the cold inner surface of the outer garment. This effect, similar to that used in a heat pipe, cold transfer a substantial amount of heat, if allowed, and would basically short-circuit the insulation. A compression-resistant insulation (open-cell foam plastic or a fibrous batting) is located next to the vapour barrier.

The selection of these two materials resulted from an extensive program to identify or develop insulation materials best suited for dry suit undergarments. These materials are being used in patches located over major muscle areas (which are the primary, heat loss sites) and as continuous garments designed to improve mobility and to prevent gross movements of trapped gas due to diver movements.

The material used in the leg and foot areas needs to be more compression resistant than that used in the torso and arm areas, where more flexibility is required. For this reason, consideration is being given to using different materials above and below the waist.

In a dry suit system, a major thermal failure would be sustained should a significant amount of water enter the suit through seal leakage or punctures. This water would be absorbed by the open-cell insulation used in conventional dry suit undergarments, and greatly increase diver heat loss. to prevent his, a material is being investigated which allows the passage of gas to permit pressure equilibration and prevent crushing as depth changes, but which is impermeable to water. Several such materials have recently become available and are being tested.

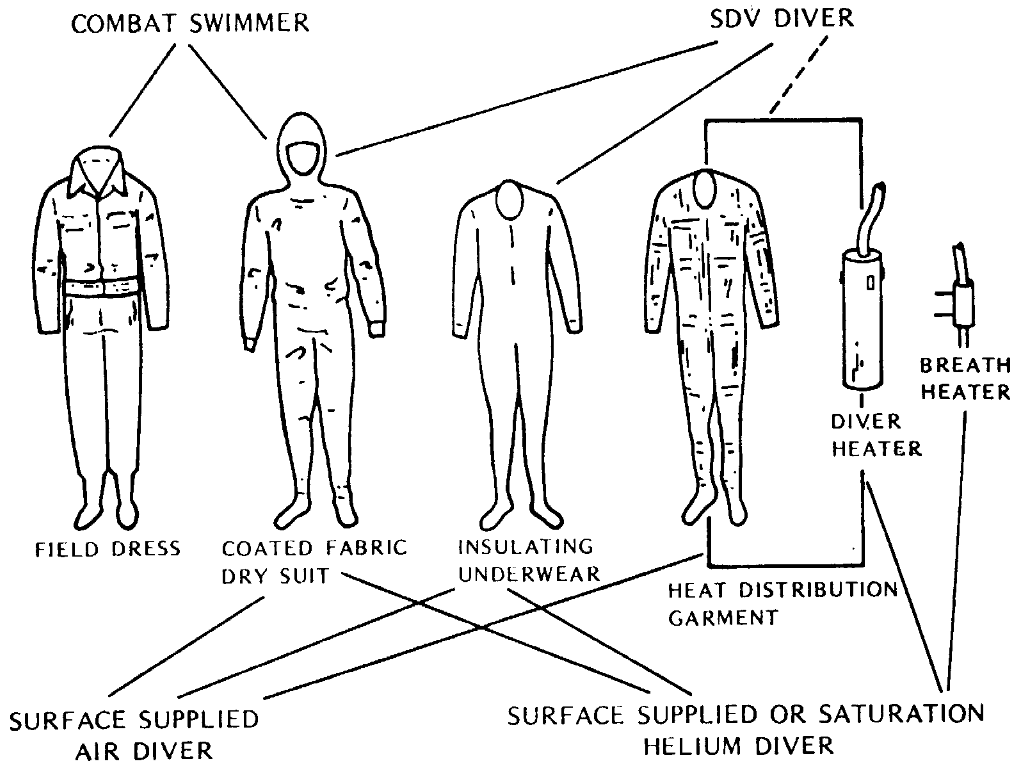
Meet The "Copper Man"

He bears a close resemblance to C3PO in "STAR WARS" but he's really a star in his own right - in what could be called "COLD WARS".

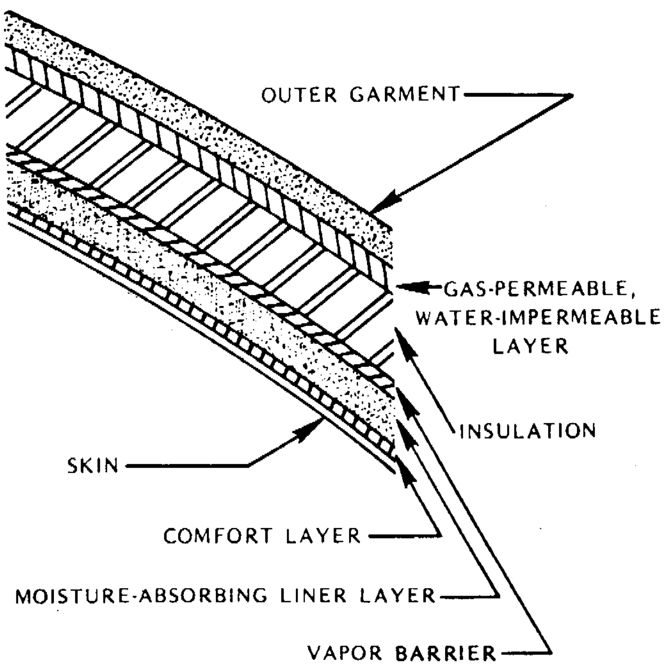
Researchers at the Naval Coastal Systems Center in Panama City have an almost ideal subject for their diver thermal protection studies - one who doesn't mind standing for hours in a hyperbaric chamber, immersed up to his neck in very cold water.

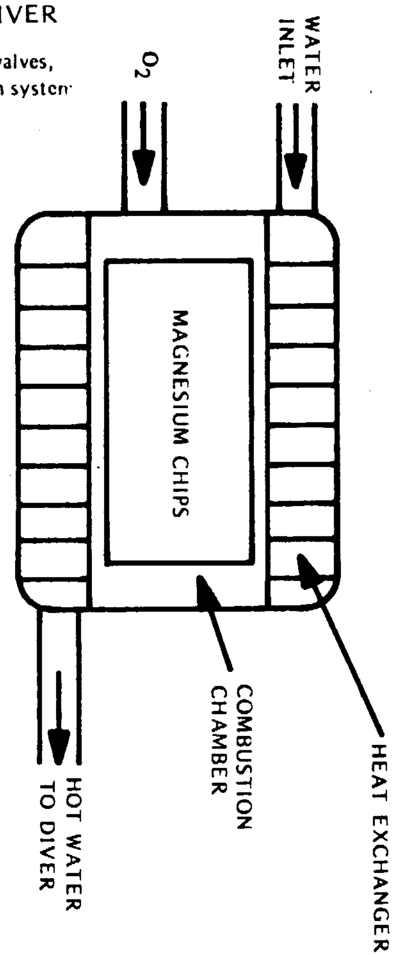
He's the Copper Man, a life-size copper manikin covered with circuits and sensors that allow him to 'feel' the effects of the cold under various test conditions. For a recent series of tests, conducted by NCSC's Diver Thermal Protection Project personnel, the Copper Man was used to determine the insulation properties of several commercial dry suits and undergarments under various hyperbaric conditions. The suits were sized to fit the manikin, and included head and foot protection, plus some specially-designed mittens.

DIVER THERMAL PROTECTION SYSTEM ELEMENTS



NOTE: System will include appropriate accessories such as gloves, valves, weight distribution system, abrasion protection, and urine collection system for each end use.





Magnesium-oxygen diver heater concept.

Because dry suits derive much of their insulation from gas trapped between the diver and suit, each suit was tested with nitrogen and helium as the suit gas.

Through those sensors that simulate skin temperature, the Copper Man revealed the following:

* Neoprene-foam dry suits provide better insulation at shallow depths than rubber-coated elastomer dry suits, but are less effective at greater depths, especially after exposure to high-pressure helium.
* The composition of the gas layer noticeably affects insulation, nitrogen provides the best insulation, followed by helium.
* The insulative value of rubber-coated suit fabric could be increased by improving the undergarment.
* Compression-resistant undergarment materials should be worn, especially in the lower extremities, to offset the effects of pressure at depth.

Although live subjects ultimately remain the best and truest determinants of the value of a given thermal suit, the (‘Copper Man is relieving experimental divers of a great deal of gruelling, cold-water testing. In the battle against the debilitating effects of cold, the diving Navy is fortunate to have the support of the Army Research Institute for Environment Medicine and their Copper Man.

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Institute of Diving

Incorporated under the laws of the State of Florida as a non-profit organisation, the Institute will be international in scope and will act for the advancement of professional, literary, and scientific knowledge relating to human orientated activity in the undersea environment.

Initial activities of the Institute are:

- Establishment of a diving museum and library at Panama City, Florida.
- Publishing a journal which addresses all aspects of diving in a professional yet understandable manner.
- Organisation of a diving information exchange program.

Membership will consist of sport, commercial and governmental divers as well as individuals, organisations and corporations interested in diving or matters diving-related. (Fees are related to membership grouping).

The Institute is the only international organisation which will be solely orientated towards the full spectrum of divers and diving activity. There is no special interest in the Institute except diving. Applications for membership to WN Brumuller, Secretary, Institute Of Diving, PO Box 876, Panama City, Florida 32401. Founder President is Dr George F Bond, Captain MC USN, Retired.

Editor:

We wish the Institute every success. With “Papa Topside” heading the team one can await with complete confidence the impact of this new force in the diving community, not least through its Newsletter.

SURVIVING A “HYPERVENTILATION BLACKOUT” - Brief Reports

It is notorious that good breath-hold divers who drown have usually done so following a pre-submersion hyperventilation and a too prolonged dive. The medical explanation is too well known to be repeated here and the practice too frequently non-fatal for warnings to be taken seriously by such divers concerning the risks (inseparable from the benefits), so the following report is presented “for the record” rather than in hope of altering the diving patterns of experienced breath-hold divers.

The victim himself has but little recollection of the events, a common finding that regrettably results in some who have experienced such blackouts failing to become alarmed at the potential seriousness of such events. He had been scuba diving with two others in 45 feet of water for about two hours. After returning to their boat they discovered that the anchor was stuck so he went back into the sea and free dived down to dislodge it, but it would not come free despite his wrestling with it for a little while. He then surfaced and was seen to wave his arms before he sank again. One of his buddies saw this so immediately dived in but surfaced again shortly, after having descended only about half the depth, to check whether the victim had resurfaced in the meantime. He then again descended and found the victim on the sea floor, unconscious, with one hand outstretched. He released the weight belt and brought him to the surface, and then to the nearest hospital. It is said that the victim was not fully revived for 1 and a half days. He remained in hospital for 4-5 days, being discharged home with no long term ill effects though with some headaches for a few days.

When questioned later he said that his last memory is of thinking that he had a long way to go still before reaching the surface (about 15 feet). There was no warning at all that he can remember of any impending blackout, no heavy feeling in the legs, no tunnel vision, and no “seeing stars”. He has no memory of reaching the surface. He is a scuba diver and had received nil instruction other than from a friend who told him “a few things”. In his 2 years he had made about 20 hours diving experience. He is not a “free diver” but was quite sure that he could reach 45 feet easily, and in fact did so.

This incident has several points of interest: it is unusual for inexperienced breath-hold divers to be able to reach the critical hypoxia level that causes a blackout, the imperative desire to breath usually occurring before this. It is unusual for effective rescue to be made by unprepared buddies. And it is unusual for a prolonged period of post immersion symptoms to leave no apparent long term ill effects. There are insufficient details available to allow deeper discussion of these points.

(Taken from “Stickybeak” non-fatal incidents files)

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Commons’ Speaker: “Rigs are Ships”

The UK House of Commons was in uproar (28 May 1976) , the votes evenly decided as to whether Oil Rigs were ships, so should be Nationalised, or Oil Rigs. The Speaker had the casting vote and disregarded the Government’s wishes by His decision that such platforms would be included in the assets that would be Nationalised. He also voted to ensure that the bill was passed. Everyone being displeased, a brawl ensued. As Divers in Australia seem to be governed under the Scaffolding Acts we can hardly laugh too loud.

Pulmonary Barotrauma: three 'first dive' incidents - Brief Reports

Three cases of non-fatal pulmonary barotrauma have been reported this year among divers in Western Australia making their first ever scuba dives in the sea. The full particulars are not available, regrettably, for any of these cases but their occurrence may reasonably be taken as an indication that a considerable number of additional incidents are occurring where the symptoms have been less clinically dramatic. Nevertheless any such case could terminate unfavourably for the victim however mild the pulmonary symptoms, the chance distribution of air emboli into the CNS being a type of "Russian Roulette" best not practiced. It is highly probably that pressure gradients that result in air entering the lung tissue planes are equally likely to injure the continuity of structure of the small blood vessels, so allowing at least some air to enter the circulatory system. It is hoped that the publication of these cases will alert those thinking of instructing someone in the art of scuba diving to first give thought to whether they themselves are adequately equipped for the responsibility.

Case 1

This man of 23 years was making a first ever scuba dive. He had previous snorkel diving experience but no recorded training with scuba. His companion's experience and training are unknown. They had a quiet dive, no strenuous activity being required, surfacing in normal manner after 45 minutes at 50 feet. After surfacing, the buddy noticed that the victim's voice was squeaky and unusual. The victim then noticed a swollen neck, that had subcutaneous crepitations, and the onset of a severe central chest pain. There was no cough or haemoptysis, no shortness of breath, no cyanosis, no paresis or paraesthesia. The buddy contacted the nearest RAN Centre and was advised to attend the nearest large hospital initially. There a right sided pneumothorax was suspected, but apparently not demonstrated. No neurological deficit was found. He was treated with oxygen through a Hudson Mask at 14 litre per minute flow rate, and later transferred to a recompression chamber for 100% oxygen at 30 feet gauge pressure. The pain was reduced by this treatment but the emphysema was unchanged. The chest pain recurred when the ascent reached 8 feet but surfacing was completed. The imperfect response was ascribed to lack of demand valve/mask delivery system for the oxygen: this matter has now been remedied. Further 1 ATA 100% oxygen treatment was given the next day as the chest pain continued, though the pain was considerably less than initially. At this time, over 18 hours after onset, the emphysema remained unreduced in degree and extent. Over the next two days the symptoms resolved and he was then discharged from care.

Cases 2 and 3

Both cases involved divers on their first scuba dive, neither having received any previous instruction in diving, the buddy in each case being reported as being "experienced". On both occasions the air supply ran out or the unit malfunctioned for some reason and both had to make a free ascent from varying depths. Both presented to the local hospital with pulmonary barotrauma symptoms limited to haemoptysis and mild chest pains. The chest X-ray and clinical examination on both cases were normal. They were treated with oxygen by mask and overnight observation without any attempt at recompression therapy. There were no known sequelae.

(These cases are from the non-fatal incidents files of "Stickybeak Project".)

A new diving hazard

The problems of North Devon’s overcrowded cemeteries could soon be solved by burials at sea.

The Reverend Donald Peyton-Jones, Vicar of Appledore, yesterday got the go-ahead from the local fisherman to use the Bristol Channel off Lundy Island for burying his parishioners.

Mr Peyton-Jones thought of the idea of sea burials after Appledore graveyard became overcrowded.

“Burials at sea are a marvellous idea,” he said. They have to be because there is no more room ashore. My yard is nearly full and although we have another field it is an the moment used by locals as allotments.

Rather than turn them off and go through the consecration of the ground it would be better to bury at sea.”

North Devon fishermen have agreed to the idea and now Mr Peyton-Jones, is hoping to get permission from the Ministry of Agriculture, Fisheries and Food. The site he is suggesting is a chartered area near wrecks in the 20 miles of sea between the North Devon coast and Lundy Island.

Even if approval is given by the Ministry, people will still have the right to be buried on land.

“We have to think about the future generation. If we go on at the present rate all they will be left with is acres and acres of graveyards. Nothing is so dismal and as unkempt as graveyards and goodness knows there are enough of them about.”

(Western Morning News, 11 July 1978)

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SUBS FOR RESCUING Stranded CREWMEN
from Sea Secrets, International Oceanographic Foundation, Jan-Feb 1978

Two Deep Submergence Rescue Vehicles (DSRVs) were formally accepted into the United States Fleet in December during ceremonies at their North Island Naval Air Station home port (San Diego, California). In operation, each DSRV is manned by a crew of four, can dive, locate and mate with a stricken submarine lying on the ocean floor at angles up to 45° can take aboard recovered crewmen, and can return them to the surface or the mother submarine hovering nearby, repeating this cycle to rescue others until all survivors are safe.

Designed and built by Lockheed Missiles and Space Company, the green-hulled rescue submersibles are 50 feet in length. Special Navy crews have been trained in their use and have developed techniques to rendezvous with stricken submarines and to operate the DSRVs either from surface ships or from mother submarines beneath the surface. The DSRVs can be land-transported on their own specially designed trucks, or the complete systems can be airlifted aboard jet transports. Thus, the highly mobile submersibles are designed to provide quick, world-wide response to submarine disasters by land, sea, or air.

Exercise Physiology

Dr T Noakes

(This paper was presented at the recent SYMPOSIUM 78 of BAROLOGIA, the South African Society for Underwater Science, to whom our thanks are due for permission to reprint.)

Exercise may be classified as either static or dynamic. During static exercise, like weight-lifting, the active muscles remain contracted for the duration of the activity, whereas during dynamic exercise, typified by running, the active muscles contract and relax repetitively. The fundamental physiological difference between the two exercise types is that during static exercise skeletal muscle blood flow is reduced or stops completely. Thus the muscle cell is isolated from the cardiovascular system and must work under conditions of ischaemia (reduced or absent blood flow). In the absence of oxygen, cellular energy requirements must be met by the anaerobic metabolism of glycogen. In contrast, during dynamic exercise muscle relaxation allows the flow of oxygen and nutrients to the muscle cell. Thus the energy requirements of dynamic exercise can be met by oxidative metabolism in skeletal muscle mitochondria, to which the metabolism of blood-borne free fatty acids and glucose can contribute.

As the two different exercise types stress different metabolic pathways, it is reasonable to expect different cellular adaptations to training with either exercise type. Dynamic exercise, because it stresses oxidative metabolism, induces adaptation in skeletal muscle mitochondria (the site where oxidative metabolism occurs). There is an increase in the number, size and enzyme content of these mitochondria. The result is that dynamically trained skeletal muscle has an enhanced capacity to generate oxidative adenosine triphosphate (ATP), particularly from free fatty acids. The effect is that during exercise the trained person produces a greater percentage of his energy from fatty acid rather than carbohydrate metabolism. As the total body carbohydrate stores are limited, and since fatigue during prolonged exercise coincides with body carbohydrate depletion, this enhanced capacity for fat in place of carbohydrate metabolism explains, in part, the superior endurance capacity of the trained person.

For reasons that are not yet clear, the cardiovascular adaptations to training (ie. the reduction in heart rate, blood pressure, and in skeletal muscle blood flow during submaximal exercise) are limited to exercise with the trained muscles. This suggests that they depend on a peripherally situated training adaptation rather than on intrinsic adaptation in the heart itself. Current evidence suggests that this is due to a training induced resetting of the synpathitic nervous system, so that the sympathetic activation during exercise is reduced by training. It has been speculated that a link exists between increased skeletal muscular oxidative capacity and reduced sympathetic activity.

Training with static exercise does not produce a change in skeletal muscle mitochondrial function. There is skeletal muscle hypertrophy through an increase in contractile proteins and this is manifest as a change in strength. No change in overall cardiovascular function occurs in persons who train exclusively with static exercises.

In summary, adaptations to physical training are absolutely specific to both the type of exercise and to the specific muscle groups used in training. Thus the best training programme for a particular sporting activity is the activity itself, provided that the activity is sufficiently strenuous to produce a training effect. Swimming therefore more closely covers the needs of the underwater diver than does running, because the latter (1) fails to train the arms, and (2) trains the hamstring muscles at the expense of the quadriceps (which are more active in swimming); or weight lifting, because it is a static exercise.

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North Queensland Diving Medicine Conference
Hinchinbrook Island

* This conference was held 28 August to 3 September 1978. Ten persons attended plus a diving instructor. Despite a run of bad luck, inclement weather, boats breaking down, etc, the North Queensland branch of SPUMS was established. The clinical sessions included lectures by Dr John Rubinson and Dr Dennis Pashen, based mainly on case histories, followed by general discussion on a wide range of topics. These included Round Window injuries, Sinus Barotrauma, Hyperventilation, Drowning, Coral injuries, and “jelly” stings.

* The SPUMS meeting was held on Saturday night and Dr Pashen was asked to continue as the acting Regional Director. It was decided to hold an in-service weekend and long weekend training sessions with guest speakers from both the north and from other states. A ten day trip to the Ribbon Reefs was organised for November (and fully filled).

* Notification of the next Regional branch meeting will be sent out to the individual members. Persons wishing to be placed on the mailing list should contact Dr Dennis Pashen, 3 White Street, Ingham Queensland 4850.

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SEA SECRETS
(March-April 1978)

QUESTION: What is the difference in metabolism and respiration that allow a lobster to stay alive for days out of the water, while a fish would die if subjected to this condition?

SV, Willimantic, Connecticut

ANSWER: Cold-blooded animals (poikilotherms) are fairly similar in their metabolic rates. Differences relate to differences in activity; eg. an active fish (tuna) would have a greater metabolic rate than the lobster which, in turn, would have a greater metabolic rate than an inactive fish (eg. toadfish).

The answer lies in the nature of the gills. For most fishes, these are very fine structures which collapse when the fish is taken out of water. They can no longer take up oxygen, and the fish dies of asphyxiation. Lobsters have coarser gills, and they can also take up oxygen from the branchial chamber. In a 100 percent humid environment, some respiration is possible, sufficient to enable the lobster to survive several days. Fishes that can take up oxygen by routes other than the gills can also survive several days in air: eg. eels and catfishes use their skin to supplement respiration. These fishes can survive several days in air if kept cool and kept in 100 percent humid conditions (eg. wrapped in wet newspaper).

QUESTION: Is it true that 1,000 dolphins are killed by Japanese fishermen in February? If so, what can be done about it?

AW, Peoria Heights, Illinois

ANSWER: According to newspaper reports, in late February, approximately 1,000 dolphins were surrounded and driven toward the shoreline of Iki Island where they were killed with either clubs or knives. The animals were apparently of mixed species, in particular, striped dolphins (Stenella sp.), bottlenosed dolphins (Tursiops sp.), false killer whales (Pseudorca sp.) and others.

The livelihoods of the Iki fishermen and the availability of food for their families depend on the local abundance of commercial fishes and cephalopods. They claimed that the sacrifices were necessary to preserve the commercial stocks which, according to the fishermen, were being fed upon by the dolphins. It appears that this activity was sanctioned by the Japanese government, with a bounty of $12 offered to the fishermen for each dolphin killed. According to present information, the dolphin carcasses were not utilized in any way as fishery products; in addition, no biological data were collected.

Whether or not these reports are completely accurate, certain facts should be considered. First, this action by the Japanese is not in violation of any existing international agreement. The International Whaling Commission sets annual catch limits on the numbers of large whales taken. The Commission is interested in the smaller whales, but has not set quotas for small cetacean fisheries. Second, the dolphins do compete with the fishermen for certain commercial stocks, and it is doubtful that there would be any feasible method, taking into consideration economic constraints, by which they could effectively drive off the dolphins permanently without harming them. Even netting and releasing the dolphins elsewhere would probably cause a certain number off deaths and would not prevent the animals from returning to the area.

Anther point to be considered is that, as of 1975, as many as 20,000 striped dolphins (Stenella coeruleoalba) were being captured every year by Japanese drive fisheries operating mainly off the Izu Peninsula, about 100 miles south of Tokyo (see “Ecological Aspects of Smaller Cetaceans, with Emphasis on the Striped Dolphin: by Masaharu Nishiwaki in the journal of the Fisheries Research Board of Canada, 32: 1069-1072, 1975). The capture method is the same as that used on Iki. International harvesting of small cetaceans is by no means a new activity for Japanese coastal fishermen. The difference is that the Izu fishery harvests dolphins to utilize the meat for human food.

A number of important questions remain after reviewing the above points. Why did the Japanese government feet it necessary to offer financial reward for this activity? Why were there no biologists on hand at least to make use of the tremendous potential of scientific information made available? Why was the kill not processed for food? The answers to these questions may become available through the efforts of organisations set up to protest and combat such actions, including the American Celacean Society, PO Box 4416, San Pedro, California 90731.

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Thor Heyerdahl, the Norwegian scientist and explorer who crossed two oceans in primitive craft says that insecticides and detergents are debilitating the seas. Heyerdahl was the main speaker at a weekend program in honour of the visit of King Olav V of Norway to Minneapolis, USA. He said future generations could be threatened with a shortage of fish and eventually oxygen when chemicals destroy vital ocean plant life.

(Australian: 13 October 1975)

Theory of Diving
"Papa Topside"

Reprinted by permission, from Institute of Diving Newsletter, Fall 1978

I would reckon that a word should be said about the theory of diving. Be assured that what will follow comes strictly from the brain of "Papa Topside", and does not necessarily relate to any given and acceptable concepts of diving practices.

Commencing with JS Haldane, we have been confronted with, and have abjectly acceded to, a purely mathematical concept of tissue gas containment. By virtue of experimental work involving JS, his oxygen-intolerant wife, and his son, plus a handful of edible pigs. Haldane developed his theory of half-time gas-tissue residuals. The concept was fabulous but quite fragile. Over the years, it simply did not hold up. As we laboriously examined the uptake and elimination gas curves so carefully derived by Dr Al Behnke and his associates, it became clear that the intake and outflow of inert gases were not at all mirror images. Technical roadblocks at that time did not permit further inspection of the most critical problems of gas transport, which is the essence of calculating decompression requirements.

For a long time, several of us in the field of diving medicine had wished to examine the concept of multiple-inert gas usage for shallow dives. We reasoned that, since each inert gas has its own individual pattern of uptake and elimination, perhaps we could put together a mixture of inerts which, if treated separately by the diver's body, might greatly improve decompression times. The weight of world scientific opinion was against us since it was accepted doctrine that the human body, for purposes of decompression, cares only for the total partial pressure of any single inert gas of many such. We could not accept this dogma, but had no safe or reliable tools to measure elimination curves of the gases we would like to use in combination. In effect, our hands were tied.

In about 1972, however, we were given access to a new tool, which combined the miniaturized mass-spectrometer "Med Spect-8" with a specialised flexible teflon-tipped intravenous probe capable of instantaneous readout of as many as five inert blood gases, plus O_2 and CO_2.

In 1974, we took off at our tiny facility at NCSL. After 18 human exposures to quintimix gases, we achieved several dives to 60 feet for a duration of 240 minutes. All of this with no decompression, and no bends symptoms. At this point we were stopped by order of the US Navy Surgeon General, and so never reached our 360 minutes/60 feet goal, which I believe possible with out magic-mix-5. No matter, it will ultimately come to pass.

(Virtually no animals subjects are acceptable for high-pressure experimental work. Small rodents are nearly unbendable; rabbits are extremely susceptible to O_2 toxicity; apes of any kind tend to have congenital lung disorders; and horses, the best choice, are too big for chambers. Let's face it, man if our best research subject.)

I guess that the main point of this discussion would simply be that although the basic laws of physics are perhaps immutable, these laws can occasionally be manipulated to our advantage. And that's the bottom line of the diving game.

SAVING YOUR OWN LIFE

Is dropping your weight belt the right response?

Lou Fead, NAUI 1413

Reprinted from NAUI News, September 1978, by their kind permission.

Divers' weights, whether on a belt or in a pack, are designed to counteract the excessive positive buoyancy of a diver, his tank and wetsuit. Weights permit him to attain neutral buoyancy for easy diving. Some divers, particularly photographers or researchers, use extra weight to offset surge or currents for more stability on the bottom. Some divers use less weight to compensate for wetsuit compression on a deep dive. Weights are designed to allow a diver to adjust his buoyancy. They are not worn to be available to a diver for jettisoning in an emergency.

Some divers who are trained with weights may later dive without them. This may be true of a diver trained with a wetsuit and weights who, on a tropical vacation, finds he does not need a wetsuit and can achieve neutral buoyancy without weights. If this diver has been trained to rely on dropping his weight belt to bail out of an emergency, he will find himself without the training for an emergency ascent when he reaches for his non-existent belt buckle.

How Divers Use Weights

Even those divers who wear weights on every dive cannot count on them as emergency devices. A recent survey has shown that weights belts often rotate during a dive so that the buckle is no longer readily accessible to the diver, or his buddy.[1]

Divers may trap their weights belts on their bodies with tanks, crotch straps, and leg knives, so that if released, the weights would still remain with them. Others may not recognize that releasing a weight belt buckle is insufficient action for attaining positive buoyancy. The belt must not only be released, but dropped and cleared of the body as well to rid the diver of its weight. Its a two handed job.

Furthermore, some divers trained in BCs who switch to integrated back buoyancy systems have not learned how much weight they need to jettison, and much less how to jettison it.

McAniff and Schene's analysis of diving fatalities revealed that most divers who die (80-90%) had not dropped their weights to save themselves.[2] Of those who had, most had been dropped by buddies or rescuers. Once a diver believes he's in serious trouble, logic is replaced by panic - unreasoning action based on fear. Dropping weights may float the victim to the surface for air and a diver without weights may be more comfortable by either floating higher or by having the restriction to breathing removed from around his waist. Nevertheless, the panicked diver tends only to recognize the need for relief, not the means for getting it.

Another survey shows that of 717 diver rescues conducted by the San Diego City Lifeguard Service from January 1, 1971, through June 30, 1975, only 12 weight belts had been dropped prior to the lifeguard arriving on the scene.[3]

The San Diego Council of Diving Clubs offers a free weight belt to any diver who had to drop his to save himself. The Council suspects that many divers don't drop their belts because it will cost them to replace it, so this program offers free replacement to encourage divers to save themselves. In two years of the program, no San Diego diver has requested a belt, although the program is well advertised. Some divers may not wish to admit it, but the data does suggest that divers in emergencies *don't* drop belts.

<u>Effect of Dropping Weights</u>

Divers in serious situations don't drop their weights. In many situations panic probably prevents the action. Yet many divers who don't panic *decide not* to drop their weights. One reason is their ego: they're embarrassed by having to confess they got in trouble. Another reason is that many believe that dropping weights when submerged may send them shooting to the surface in a cloud of bubbles and ruptured lungs. It doesn't happen that way.

In open-ocean experiments, 16 instructor candidates, naturally buoyant at the surface, ditched their weights at 30 feet, relaxed and floated to the surface.[4] The average ascent time was 20 seconds, just half again as fast as the maximum proper ascent rate - 60 feet/minute.

TABLE 1

DEPTH	**WEIGHT FOR NEUTRAL**	**ASCENTS TO SURFACE**			
		Drop Weights Only		**Kick Twice Only***	
(feet Seawater)	(pounds)	Time (sec)	Av Rate (ft/sec)	Time (sec)	Av Rate (ft/sec)
0	15	-	-	-	-
16.5	12	6	2.75	-	-
33	9	13	2.54	16	2.06
66	3	69	0.96	78	0.85
99	2	-	-	-	-

* With BC inflated to neutral buoyancy and weight retained.

A more recount examination open ocean of the weight belt effect on a wet suited scuba diver confirms that dropping does not result in a headlong rush to the surface (Table 1). The test was made to quantify buoyancy and ascent effects on weight and depth.

Comparison of figures in the column entitled "Weight for Neutral" shows how much floatation the diver's one quarter inch Farmer John, nylon 11, hood attached wetsuit lost on descent. It was measured while wearing a single-70 tank deflated vest, and a weight belt weighted for neutrality at the surface. Neutrality was achieved on the surface when breathing from a regulator: the diver floated with his eyes slightly above the water's surface.

Diving to stated depth, the diver removed excess to re-achieve neutrality in which full lungs caused him to ascend and empty lungs caused him to descend. (The little weight needed at 66 feet and deeper shows that dropping a 15 pound weight belt does not necessarily make a diver 15 pounds more buoyant. In fact, the change in buoyancy when losing a weight belt in 70 feet of water could go almost unnoticed).

Ascents were made from typical depths of 33 and 66 feet. The first ascents labelled "Drop Weights Only," had the diver drop his weights, without being neutralized first. He relaxed, breathed normally, and ascended with no other effort to reach the surface. An unconscious diver would be rescued in a similar manner. The ascents started slowly and gained speed as the wetsuit expanded to resume its uncompressed buoyancy. Note that the rate of ascent after jettisoning weights is much greater in shallow water than in deep.

The second ascent, "Kick twice only," had the diver adjust his vest buoyancy to achieve neutrality at depth, then push off the bottom and make two strong kicks. After that he relaxed and breathed normally for the remainder of the ascent.

Without some strong kick, just pushing off the bottom did not result in an ascent. The "Kick" ascent is equivalent to a neutralized diver's heading toward the surface to let the air in his wet suit expand for additional lift. This technique is recommended for normal ascents. It can, with some venting of excess vest air near the surface, control an ascent at 60 feet per minute quite handily.

In Review

It's apparent that weight dropping is not frequently used by divers as an emergency action in time of stress, regardless of the depth of the dive.

Second, at depths up to 60-70 feet, a dropped weight belt on a diver who is neutrally buoyant would provide sufficient lift to get the diver to surface with no expended energy, but the speed of ascent might not be sufficient to satisfy the emergency.

And, if a diver at a greater depth is not neutrally buoyant, his dropping a weight belt may not lead to his ascent. The greater the depth, the greater the validity of the statement.

At depths below 60-70 feet, a neutrally buoyant diver can ascend quickly if necessary by dropping weights and kicking up. Our experiment yielded an ascent time of 20 seconds for a 66 foot ascent.

Dropping weights is not the proper reflex action in diving emergencies. Dropping weights cannot be solve all problems. Dropping weights *cannot* be counted upon to save lives.

The solution in emergencies is the too often stated but all too true *thinking and acting*. In fact, the thinking begins with dive planning so equipment is well maintained and does not fail, so the diver does not run out of air, and so he does not need sudden positive buoyancy. Dropping weights, which is *not* the solution, only makes a diver lighter.

Essentially, safe divers avoid the need for sudden buoyancy. Practice of the following techniques of buoyancy control can help avoid the need for sudden buoyancy.

1. Weight yourself to be neutrally buoyant at the end of your dive, in the shallowest water you intend to explore. You will be a few pounds heavier when starting your dive, but you can offset that by adding a little air to your BC.

2. If positive buoyancy is needed during a dive, you can:

   a. Breathe with *fuller* lungs. A typical diver's lungs can provide up to eight pounds of buoyancy, but normal breathing provides about half. Fuller breathes can add buoyancy.
   b Kick up. The closer you are to the surface, the greater your buoyancy changes as you ascend. A normal kick provides about 15 pounds of thrust, the same as dropping 15 pounds of weight, but kicking is tiring.
   c. Inflate your BC to gain controllable floatation, and vent the excess air to slow your ascent.
   d. Drop your weights. It's a last ditch effort which does not normally allow reversal of the action (you don't regain the weight) and you will ascend sooner or later.

If you can't think of anything else to do and you are indeed in an emergency, drop your weights.

But if you are going to rely on dropping weights for solving emergencies, stay out of caves, kelp, wrecks – and don't ice dive. In those situations, dropping your belt can pin you against the ceiling forever.

FOOTNOTES

1. Hardy, Jon and Bear Sleeper, Jeanne. The Last Ditch Attempt - Weight Systems. *Proceedings of the Eight International Conference on Underwater Education*. Colton, California: NAUI, Nov 4-7, 1976.

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3. Bruton, Al and Fead, Lou. The Lifeguard's Headache. *Proceedings of the Seventh International Conference on Underwater Education*. Colton, California: NAUI, Sept 26-28, 1975.

4. Graver, Dennis K. In Support of Emergency Ascent Training. Addendum to *Proceedings of the Eight International Conference on Underwater Education*. Colton, California: NAUI, Nov 4-7, 1976.

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Brief Profile

Kenneth Richard Tuson joined the RN Scientific Service as Scientific Assistant at the Admiralty materials Laboratory, Poole, in 1947, and by 1950 was working on instrumentation, high speed photography, the physics of bubble production and problems associated with diving research.

His work then developed into diving navigational system studies in stream lining, the development of breathing apparatus, and trials thereof.

He obtained special leave to work as Project Manager for DHB Construction on the production, testing and trials of JIM, the armoured diving suit.

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TABLE 1

Diving Experience, Pre Service and Service History, and Medical Information on Young and Old Divers

Diving Experience	Young Divers Av.	Young Divers Variability[c]	Old Divers Av.	Old Divers Variability	t[a]	Level of Significance[b]
Yrs of Naval Service Before Qualifying as a Diver	2.17	1.69	7.88	3.59	6.088	Over 1 in 1000 (highly significant)
Yrs of Diving Experience	2.22	0.65	9.65	3.57	8.682	Over 1 in 1000 (highly significant)
Total No. of Dives/Yrd	38.13	19.19	22.51	15.77	2.622	Over 2 in 100 (moderately significant)
Dives/Yr at 40°F or less	5.94	10.55	1.63	1.93	1.659	Between 10 and 20 in 100 (not significant)
Night Dives/Yr	0.33	0.49	2.12	3.14	2.383	Over 5 in 100 (significant)
Dives/Yr below 50fsw	8.09	5.60	5.15	2.78	1.950	Between 5 and 10 in 100 (not signif.)
Diving Accidents/ Yr (self-report)	0.45	0.33	0.13	0.09	3.969	Over 1 in 1000 (highly significant)
Special Diving Recognitions/Yr	0.14	0.22	0.23	0.18	1.244	Between 20 and 40 in 100 (not significant)
Pre-Service and Service History						
Pre-Service Delinquency Problems	2.06	1.35	2.53	1.28	1.064	Between 20 and 40 in 100 (not significant)
In-Service Disciplinary Actions /Yr Service	0.08	0.15	0.10	0.15	0.566	
GCT scores	58.59	7.72	55.33	8.40	1.142	Between 20 and 40 in 100 (not significant)
Medical Information						
CMI scores	15.00	23.11	14.59	10.04	0.068	Near 50 in 100 (not significant)
Sick Calls/Yrs Diving	2.29	2.26	1.54	0.96	1.266	Between 20 and 40 in 100 (not signif.)

a See footnote 4.
b See footnote 4.
c Variability is used to designate the spread of scores (standard deviation) around the average score; the lower the variability, the better (or more reliable) are the scores.
d "Yr" indicates per years of diving experience

PROJECT STICKYBEAK

Further reports are always welcome and will always remain CONFIDENTIAL as to source and victim. Cases are welcome whether serious or minor. Of the greatest interest are reports of instances where an Emergency Situation either occurred or seemed likely to occur. Comments and additional advice concerning cases in this or previous Provisional Reports are welcome.

Please write to: Dr DG Walker, PO Box 120, NARRABEEN NSW 2101

THOR HEYERDAHL, the Norwegian scientist and explorer who crossed two oceans in primitive craft says that insecticides and detergents are debilitating the seas. Heyerdahl was the main speaker at a weekend program in honour of the visit of King Olav V of Norway to Minneapolis, USA. He said future generations could be threatened with a shortage of fish and eventually oxygen when chemicals destroy vital ocean plant life.

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