SPUMS JOURNAL

South Pacific Underwater Medicine Society

JANUARY TO MARCH 1980

"WELL, DO WE BUY ONE OR DO WE RELY ON A SPEEDY ASCENT?"

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Registered for posting as a publication (Category B). Printed by: Accuprint Print & Copy Service, 945 Whitehorse Rd., Box Hill, 3128.

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E D I T O R I A L

Kenneth Bell, one time tutor at Oxford University, used to advise his new students on the role he saw as appropriate for the University. "It's our purpose here to make you think rather than to know, but please remember that in order to think it is necessary to know." This is excellent advice, which this Journal seeks to apply and which is illustrated in Paul Wethersby 's paper, the discussion paper concerning practice of Emergency Ascents, and other articles. Differing views on type causation of decompression sickness result in the coexistence of different bases for the calculation of the Dive Tables. As no Tables have a built-in loading factor to represent the variables now generally recognised as effecting the outcome of any decompression even the best possible advice will have a rough and ready aspect in its application to the average diving situation. This would be unacceptable but for the remarkable stress survival systems of the human body (and of the animal bodies used to make the initial tests). The safety of Tables is calculated by titration against reported morbidity, and divers view with disfavour time spent in Therapeutic Table incarceration in a Chamber. This will produce an inbuilt bias towards crediting any given schedule with an enhanced safety record. The observer habit of pre-judging DCS victims of having de facto deviated from the Table times and tried to hide the fact (not invariably true!) makes for unwillingness to use dive details from DCS treatment centres to assess different theories by evaluating the results of using the derived tables. In this respect the statement by Paul Wethersby that most "practical" diving experience does not contribute to our understanding of which decompression theories work better than others is realistic. But practical diving is the name of the game and it is surely time for more attention to be paid to "real diving" as well as to straight-up-and-down work. As long as people talk seriously of DCS following a no-decompression dive the "don't confuse me with facts" subscribers to current dogmas will prevail.

It is only in recent times that the significance of factors beyond those of dive time and depth have been considered. Tiredness, emotion, cold, alcohol, CO_2 are now accepted as obvious requiring writing into the dive profile. It has taken the increasing female involvement into diving to draw attention to the importance of (sex) hormonal changes, a matter male Experts were slow to recognise. It is to persons like Susan Bangasser, represented here in a valuable review of her recent researches, that recent interest in such factors must be given in large part.

There must be testing of changes in equipment and dive profiles, but such evaluation must be carried out responsibly. Michael Curley and his colleagues are working within strict regulations but many workers are likely to feel frustrated by "limitations of red tape" and to claim Necessity for "pushing on regardless". Willingness, whether based on faith or ignorance, does not justify such actions. It would be a foolish fellow indeed who believed that Experts were always right in their prognostications, for even the egg heads who designed the Atom Bomb forgot the danger of radio-active fall-out and in SEALAB III breathing equipment was used for a 500 ft dive after being tested (and found wanting!) at 60 feet. So the moralising of the Opinion Corner may just be relevant to any of us one day.

Necessity is a dangerous word, often used to stifle constructive thought on alternative approaches to some problem. The hoary subject of the teaching practice relating to emergency ascents is aired here again, more by making facts available than by any direct argument. The information available from Incident Reports is the only valid ammunition for such discussions, and that available from BS-AC files is revealing despite unfortunate inadequacies of critical detail. So support reporting schemes.

On a less elevated level of philosophy there are papers to draw our attention to the marine dangers which may effect the diver. Dr Charles Brown, a welcome author who has been displaying his wit and erudition to the American divers for many years and is now sharing his information with us also, reports on a memorable holiday dive. One may hope that his buddies are now aware of their non-buddy diving pattern. Mr Tony Edmonds reminds us that the humble "bluebottle" can pack a wallop; though divers are to a large degree protected by their wet suits they can be considerably troubled should stings occur on their face or neck. Non-Australian readers will be relieved to find that we can still report a SHARK ATTACK! Australian readers will be relieved to find that it was non fatal and that the response of those involved was correct. Thomas the Toad-fish illustrates the trueism that it can be a mistake to draw attention to oneself .... a possible explanation for the occasional unsigned article.

Correspondents Letters make a welcome return, a great pleasure to The Editor, who was beginning to wonder whether there was anyone alive out there where the mailman left the Journals. They, and all contributors and donor Journals are thanked for their involvement in this publication.

MEDICAL ASPECTS OF SPORT DIVING INCIDENTS: BS-AC REPORT 1979

The annual report of the British Sub-Aqua Club's Diving incidents Panel (Chairman George Skuse) was presented recently to the BS-AC Diving Officers Conference. In addition to a statistical summary the report provides brief incident reports which "flesh out" the numbers into people. Not unexpectedly these reports are often frustratingly incomplete due to the unfortunate inability of the diving community to recognise the value of informative reports, or indeed of making any report, but nevertheless the Panel has carefully presented not only the facts known but has indicated the basic details that are unavailable. Critical factors include hypothermia, pulmonary overpressure, water aspiration, air embolism, and additional uncertain factors. Inadequate reports increase uncertainty as to causes. It is hoped that future reports will include the age of the victim among details, a fact available concerning only one incident this year, even though this may require much effort in persuading their informants to co-operate.

In general terms the report shows the increasing problems arising from cold water diving, because not only are divers finding themselves without air at depth because of freezing of the reducing valves but there was one death and two significantly affected divers due to hypothermia and one boat crew member was incapacitated, putting herself and the divers at risk, from this cause. Decompression sickness cases demonstrated once more that it can be unsafe to ignore the advised stops and that in-water treatment is unsuccessful. It is apparent that some divers have equipment enabling them to stay longer and deeper underwater than their education makes safe. As one such victim had survived Spinal Bends the previous year without apparently learning from the experience, this problem will be difficult to solve. Delays in obtaining RCC treatment occur, though in one case this was due to unavailability of facilities. The multifactorial nature of many incidents is illustrated in some of the ENT, cold, fatigue, drink cases. No drugs other than alcohol were reported. Illness as such was represented by two fatal "heart attacks", the previous health of neither victim being given. One Epileptic fit occurred on a beach in association with vigorous activity attempting to launch a boat, previous health not stated. A mixed bag of trauma was reported which illustrated the value of first aid training as a part of the diving course. The most significant non-medical fact to emerge was the importance of boatmanship, a danger area previously well identified by the BS-AC and a subject being tackled actively by them.

The report fully justified the work of the members of the panel and it is hoped that they will receive increasing support from divers. Not all the cases involved BS-AC members and some occurred outside the UK. A few of the cases are presented to amplify the above condensed account.

CASE NOTES:

Cardiac:

Case 100: This 59 year old man of unstated experience and previous health, experienced ear problems on descent but nevertheless reached 22 metres before aborting the dive. He suffered a "stress induced heart attack" when re-entering the boat and died despite the resuscitation attempts of his buddies.

Case 113: The age, experience and previous health of this man are unknown. He had surfaced normally and was snorkelling back to the shore on the surface when he was taken ill and died. Subsequently he was found to have had a "heart complaint", but whether anyone was aware of this is not known. The Coroner commented on the need for minimal health standards for divers, but in the absence of more facts the relevance of medical checks to the prevention of heart attacks is problematical.

Drink:

Case 23: The combination of too much to drink, too little sleep, and 140 miles drive to the dive site resulted in him being taken ill at 33 metres and requiring rescue.

Case 32: First he dropped his weight belt, which was recovered by his buddy, so the dive started after a 10 minutes wait in the water. After 18 minutes he felt cold so returned to the boat and then to the shore. He "felt in a dream, then fell unconscious" after first shouting "I've got a bends", clutching his elbow and having what looked like a fit. He was taken to HMS Drake where he was diagnosed as suffering from hypothermia. Dive depth 21 metres. Late nights and drink were thought to be significant factors in this incident.

Trauma:

Case 49: Victim slipped while fully kitted up, fracturing the tibia and fibula in one leg. The ambulance was called but cancelled, the diver remaining sitting at the waterside till the diving officer took him back home for lunch. The victim's father was asked to come to take him home but decided to seek advice at the hospital. There was therefore a 6 hour delay before the condition was treated, but presumably the pain and disability were not great, and the wet suit may have provided initial support and led to an under-estimation of the injury.

Case 14: The diver's marker buoy line became tangled just below the surface when the engine was started in gear by mistake. The boat ran over the diver, cutting his foot (14 stitches were required later). There was slack in the gear lever and the throttle was not marked with the starting position, and the two crew had not used this engine before. Luckily there were five qualified first-aiders in the boat.

Case 65: After a night dive the torch was recharged, then switched on to test. It exploded, causing the loss of one eye. The torch had leaked and produced oxygen and hydrogen by electrolysis, this mixture exploding when the switch sparked.

Cold:

Case 117: A slightly-built trainee snorkelling in cold water (5°C) became unconscious from hypothermia. He was thereafter judged to be emotionally and physically unsuited for diving and he gave up the sport. It is obvious that the club failed to recognise the dangers of hypothermia from cold water and responded late to the warning signs. He was, however, rescued and suffered no known damage.

Case 31: This snorkel diver went in from a boat, said it was bloody cold, drifted back, lost control, and died from hypothermia at the surface. One would like much more detail concerning this tragedy.

Case 79: The divers came ashore after their boat, a motor cruiser with two outboard engines, had disappeared. The boat was found by the Navy two and a quarter hours later. It had no lights, no flares, no radio, and one inexperienced girl as crew. She was suffering from hypothermia

Loss of Consciousness:

Case 68: After surfacing from an apparently normal dive at 16 metres he suffered head pain, blurred vision, vertigo, vomited and then lost consciousness. He was transported by helicopter to a RCC where he was recompressed in retrospect his symptoms were ascribed to severe sinus pains.

Case 74: This diving officer dived for 18 minutes at 45 metres and then started a normal ascent, carrying scrap. At 27 metres something happened and he became unconscious, lost his mouthpiece, and drowned. His buddy brought him to the surface by inflating his lifejacket. The resuscitation attempts failed. Possible causes include pulmonary over-pressure, air embolism, and water inhalation.

Case 25: Deceased was the last of a party of three to enter the water. He was noted to show signs of confusion while kitting-up, but the others apparently were not alarmed by this. He was a 3rd class scuba diver of unknown experience and recent health. While returning to the surface, from 33 metres "he just went unconscious", lost his mouthpiece and drowned. A buddy brought the body to the surface but resuscitation failed.

Case 12: Diving for shells and constantly seeing a better one a little deeper, this experienced 2nd class diver reached 65 metres. When he felt ill he managed to inflate his ABLJ before blacking-out. His buddy, separated from him at this time, surfaced eventually after him. Nitrogen Narcosis is suspected to be responsible here.

E N T

Case 13: Trainee burst an eardrum on diving to the bottom of a 4 metre pool. He had previously received the relevant lectures.

Case 114: The dive required much changing of depth by a diver who was usually slow to clear his ears. After one particularly violent Valsalva he experienced dizziness and required rescue. Depth 11 metres.

Case 37: Open Water Rescue Course. Ear clearing problems caused delays leading to one participant running low on air and making a buoyant ascent from 22 metre. There is no mention of contents gauges on the information code of this investigation, unfortunately.

Pulmonary Barotrauma:

Inadequate details are available concerning symptoms so it is not possible to evaluate.

Case 46: A trainee was refitting his scuba, for the first time, at the bottom of a 5 metre pool. The instructor snorkelled above, watching. The trainee was seen to be having difficulties so the instructor swam down to tell him to come up. Unfortunately he had taken some breaths from the scuba and ascended without breathing out. He was diagnosed as having a "burst lung" and two days later received treatment at a RCC (sic!).

Case 109: This diver, of unknown experience, became short of air while diving off the Scillies and surfaced from 39 metres without stops. As he was preparing to re-enter the water with a fresh air supply he was struck by an embolism. He received successful RCC treatment.

D C S:

There were two cases diagnosed as spinal bends and eleven other cases, all except two (one in each group) receiving RCC treatment. Two divers had used a DCM and most used imagination and hope in preference to strictly adhering to Tables. Five attempted some degree of in-water therapy before attending a RCC. Only one diver was stated to have residual disability. (See Table 1)

Case 21: A trainee diver, not in the UK, suffered "a mild spinal bend" after a 25 metre dive of unstated duration. There was a 28 hour delay in seeking treatment because he thought that he was suffering from 'flu. No recompression was deemed necessary-

Case 64: During his ascent from a dive at 51 metres for 30 minutes this 2nd class diver made stops 15 metres for 2 minutes, 9 metres for 8 minutes, 7 metres for 15 minutes. He should have taken stops of 20 metres for 5 minutes, 10 metres for 10 minutes, 5 metres for 100 minutes. He claimed to use both a DCM and the BS-AC tables, converting metre measurements to feet "in a highly individualistic way". His first symptoms occurred during the 7 metre stop, but he delayed seeking advice for 7 and a half hours, then took another 4 hours to reach the RCC, at HMS Vernon, very definitely "bent" by this time. He had been treated there the previous year for quadriplegia so was advised to give up diving:

COMMENT:

The occurrence of intercurrent illness, which in the case of diving incidents appears to be confined to a Heart Attack, during the exertion of a diving situation cannot be completed predicted and to some degree must be accepted as an unavoidable accident. This would not hold true if the victim had suffered previous recognised symptoms, but such a history is not available for a variety of reasons in most cases. The singular absence of angina of effort or of other illnesses points to the probability that many cases are occurring but remain unreported.

Trauma, should it occur, complicates the uneasy balance of safety/danger factors present in any diving situation. Rapid correct treatment can obviously be vital, a cogent argument for the teaching of basic first aid to all divers.

Case	Dive Depth	Dive Time	Ascent Stops	In-water Treatment	RCC	Onset of Symptoms	Delay in Treatment	Comment
21	25m	?	?	No	No	?	28 hours	"mild spinal bend"
66	15m	?	No	No	Yes	?	?	Spinal bends: felt ill so emergency ascent without stop.
64	51m	30 min	Yes (Wrong)	No	Yes	at 7m stop	?	Used DCM. Previous spinal bends.
59	38m	?	?	Yes	Yes	? in water	?	Pains increased during in water treatment attempt.
86	28m	?	?	No	Yes	2 hours	29 hours	A "by the tables" dive.
88	46m	33 min	No	Yes	Yes	?	?	Separated from buddy. Gross errors in decompression time performed.
90	28m	?	No	No	Yes	?	?	Difficulty finding ready RCC.
110	?	?	?	?	No	?	?	Helicopter to RCC for check
116	38m	20 + 18' mins.	Yes (Wrong)	Yes	Yes	?	?	2 dives, inadequate stops.
6	34m	25 min.	Yes	No	Yes	In water	?	Inadequate stops + exertion.
101	23m	25 mins	No	Yes	Yes	In boat	6 mins	Inadequate ascent stops.

ENT problems plague many divers. It is demonstrated here that they may lead to the development of more serious problems. The old advice that one must not force equalisation, and should abandon a dive if the trouble fails to resolve easily and completely, has much to commend it.

Drink, fatigue, cold and other factors reduce the safety margin for the diver and all have the special danger of being insidious in their effects. The wise diver avoids factors that put him at avoidable risk. Only a fool thinks that putting up with cold is tough: it is thick!

Pulmonary Barotrauma and Decompression Sickness cases presented show nothing not already known, including the fact that some divers have little or no appreciation of the dangers they run if they make their own rules for decompression stops. Rather it is remarkable that so few cases occur among such people.

TABLE 1
DECOMPRESSION SICKNESS CASES

OPINION CORNER continued from Page 12.

REFERENCES:

1. Hughes, Stein, Lunch. Hopelessness induced sudden death in rats. *Journal of Nervous and Mental Disease*. 1978; 166 (6): 387-401.
2. John Marks. *The Search for the Manchurian Candidate* (as reviewed in the Sydney Morning Herald 20 and 27 October 1979).
3. Drummond Rennie. The Ethics of Medical Publication. *Medical Jnl Australia*. 1979; 2: 409-412.
4. Editorial. Still no truck with torture. *Medical Jnl Australia*. 1979; 2: 637.

A BITE TOO MUCH FOR THOMAS THE TOAD FISH

Thomas will surely grudge Mr Spooner his $20 bounty but if he'd kept his big mouth shut he would still be the terror of Shute Harbour, a beach resort near Mackay. Mr Spooner, on holiday from North Rocks (NSW), received some assistance from coastguard Noel Robinson who had led the hunt for Thomas since he bit two children last weekend and attacked four other people over the past couple of months. It was this behaviour that led the local townspeople to fork up the prize money for anyone who could rid them of this piece of bad publicity, for biting chunks out of paddlers is held to be anti-social and tourist-deterring. Yet Thomas was no second "Jaws", but only a toadfish that seems to have held too firmly to his belief in territoriality. He straightened two squid baited hooks before a third one got him: perhaps he thought the local Tourist Board was trying to buy him off?

Marine biologists are quoted as being mystified by Thomas' attacks as toad fish are not supposed to bite people, though their flesh can be highly poisonous if not specially prepared for eating. It is a delicacy in Japan where only specially licenced chefs are allowed to prepare it. Its eating is spiced by the knowledge that if the chef is having an "off" day you won't be eating there again ... ever.

Thomas weighed 1.45 kg and was 46 cm long and was no beauty even before he was dispatched by a rock-wielding Mr Spooner. The squashed remains were sent to James Cook University at Townsville to try to determine why he was so vicious as to bite people.

(Daily Telegraph - 17th January 1980)

TABLE 1

REPORTED EMERGENCY SITUATIONS: BS-AC DIVING INCIDENTS PANEL 1979

Primary Factors
- Illness (Cardiovascular, Hypothermia, Epilepsy)
- Trauma
- Pulmonary Barotrauma/Air Embolism, aerophagy of compressed air
- Decompression Sickness
- Boat related problems
- Diver washed from boat
- Surface near/drowning
- Underwater: loss of consciousness
- Underwater: loss of air supply — demand valve fault; low/out of air situation
- Air supply problems

Air Supply Problems

1. Freezing of reducing valve, DV (F = fresh water)

Case	Certification	Depth	
10/79	2nd class	F 45m	1st stage froze open, then closed; buoyancy ascent using separate-cylinder-supplied ABLJ; functioned at surface.
18/79	snorkel	F 7m	DV froze free flow; assisted ascent; pulmonary barotrauma, DV functioned again at surface.
16/79	2nd class	F 8m	DV froze free flow; used DV to ascend: "Air was dry".
17/79	2nd class	F 8m	DV froze free flow; aborted dive: high peak flow DV.
19A/79	3rd class	F 7m	DV froze (?open ?shut); assisted ascent.
19B/79	3rd class	F 7m	DV froze (?open ?shut); assisted ascent.
36/79	? ?	F ?	DV froze (?open ?shut); open water rescue course; assisted ascent.
87/79	3rd class	F 33m	DV froze (?open ?shut); assisted ascent using buddy's DV while he used octopus DV; moisturiser on DV.

F = fresh water

2. Low/out of air situation

7/79	"Trained"	24m	Out of air, club dive; buoyant ascent, prior scuba experience.
37/79	2nd class	F 22m	Ear clearing problem left him low on air during open water rescue course; buoyant ascent.
57/79	? ?	40m	Out of air as 2nd descent; both he and buddy breathless so buddy breathing failed; buoyant ascent and inflated vest.
60/79	? ?	?	Out of air; failure of buddy breathing then separation, buoyant ascent: DIED. DV found to be faulty.
20/79	trainee	20m	Out of air so ascended alone; club dive; Air Embolism.
109/79	? ?	39m	Short of air so ascent without required stops; Air Embolism after surfaced; RCC treatment.
41/79	? ?	F 21m	Shared with solo diver who out of air; DV not returned so free ascent by donor diver.
9/79	3rd class	21m	Out of air as contents gauge faulty; neck strap prevented buddy breathing ascent.
1/79	Instr.	20m	DV became "tight", gauge showing fluctuations; buddy turned tank on fully while further 5m descent; function OK.

3. Demand valve causing air problem

2/79	? ?	F 22m	DV stuck free flow when purged: surfaced: air turned off then on, then DV functioned normally.
30/79	3rd class	F 30m	DV stuck free flow, as happened before; assisted ascent, hard finning required as buddy's ABLJ XS buoyant; swallowed air; X-Ray no signs pulmonary barotrauma: Narcosis a factor.
44/79	Instr.	2m	DV stuck free flow on 3rd use, dive aborted: faulty DV.
52/79	3rd class	34m	DV "tight"; no distress during dive, vomited at surface, became ill, cyanose. Suspected pneumothorax not confirmed.
60/79			See notes above. Possibly not "out of air" but DV fault.
3/79	Trainee	F 10m	DV satisfactory at 7m, "tight" at 9m, assisted ascent; DV had been incorrectly serviced.

Other Emergency Situations

80/79	3rd class	7m	ABLJ open water exercise. Direct feed incorrectly fitted: "took in water" so buoyant ascent.
74/79	Club DO, ? certif.	45-27m	Ascent carrying scrap; sudden unconscious at 27m, lost DV, DIED: buddy inflated vest and surfaced body.
25/79	3rd class	33m	Confused while kitting-up (?ill); became unconscious on ascent, lost DV, DIED.
92/79	? ?	1m	Seasick so tried to dive; took in water changing snorkel to DV; buddy inflated vest and towed him to shore.
12/79	2nd class	65m	Diving deeper and deeper for shells; felt ill so inflated ABLJ before blackout' buoyant ascent: Narcosis factors.
24/79	3rd class	8m	Dark, cold dive; no air in ABLJ cylinder so difficulty in surfacing, hitting buddy violently: helped ashore.
114/79	Snorkel	11m	Much depth changing; difficulty equalising ears; violent Valsalva made dizzy; needed rescue.

DISCUSSION PAPER: SHOULD EMERGENCY ASCENT PRACTICE BE MANDATORY?

Douglas Walker

The NOAA financed Workshop on Emergency Ascents Training, held in December 1977 under the umbrella of the Undersea Medicine Society, reached conclusions which will effect the training experience of thousands of trainees each year from now onwards. The Proceedings have not yet been published but it is known [1] that "the decision of all the diving training groups was unanimous that their staff* be trained in emergency ascent, otherwise they were morally irresponsible since many of the accidents occur because of panic associated with an emergency situation. It was recognised that there was a very remote but finite chance of a fatal accident during the training episode. But without training there was a much greater probability of a fatality should any emergency arise." This policy statement contains serious misstatements of the lessons many would draw from an impartial examination of the records of both fatal and non-fatal incidents, for the implication is that the deaths occur because of the non-inclusion of Emergency Ascent Practice in the present courses of instruction. The general lesson that accidents illustrate is that ignorance and the absence of a contents gauge and a functioning buoyancy aid are the critical factors, panic being a critical stage in the incident but not the initiating factor. Training courses would benefit, it may be suggested, by being longer and providing much more supervised actual practice of diving's basic skills. These include correct assessment of problems before entering the water, correct weighting, correct equipment, correct dive discipline, and recognition that reaching the surface does not mean that end of danger. The present position is that major Instructor Organisations in the USA, and at least PADI in Australia, are now requiring the performance of a controlled "out-of-air" ascent by all pupils in the belief that thereby they are increasing diving safety. It seems legitimate, therefore, to present some of the more recently available information from the UK and Australia, with a little from the USA for good measure, so that an informed assessment of the situation can be made without excessive awareness of the implied UMS imprimateur when the Proceedings are finally published. The question at issue is not whether a diver who has "overlearnt" to make out-of-air ascents is better prepared to survive such situations, but rather whether the performance of a single or a few such ascents by a novice diver during his training is the most appropriate and safest option for the production of a safe basic scuba diver.

It is accepted that many incidents go unreported, especially those where the correct remedial action prevented the progression of a problem into a more serious difficulty. It is regretted that information on critical points is often incomplete. Nevertheless discussion can only be based on the available facts, though subject to possible revision should fresh data become available. However many incidents leading to diver morbidity similarly remain unreported, because the doctor or medical centre has too few cases to bother to write them up in a Journal. The absence of reports cannot be taken as proof that morbidity does not exist, merely that Incident Reporting Schemes are inadequately utilised by the diving community.

* (this appears to include pupils).

A. INCIDENT REPORTS

The information presented in Tables 1 and 2 is from the recent BS-AC report[2] while that in Table 3 is from the Provisional Report on the 1978 Australian diving deaths.[3] No cases have been withheld and all relevant details are shown, omissions signifying information not available to those writing the original reports. Table 4 gives resumes of the cases of diving-related barotrauma of ascent in the US Navy report. Emergency Situations have been classified for purposes of simplicity of discussion, only those where the incident occurred underwater and therefore the matter of skill in Emergency Ascent may be relevant having the available facts tabulated (Table 1). The heart attacks both occurred while re-entering boats, the Epileptic fit occurred on the beach after failure to launch a dive boat into a rough sea, and the Hypothermia case was in a snorkel diver floating quietly at the surface. Trauma, Air Embolism, etc., were also surface emergency situations. This restricts the cases requiring further consideration to those where the victim became unconscious (and immediate ascent was the necessity for life) or experienced difficulty with his air supply.

1. Freezing of reducing valve. Where free-flow occurred a trained, calm diver could breathe his way to the surface. In several cases it was not stated whether free flow or cessation of flow occurred. It is obvious that fresh water dives in freezing water require special planning and that the real answer should be equipment-orientated rather than by acceptance of air-loss and emergency ascent. Such dives should only be made by those specially trained in such a branch of diving. The dangers are predictable and should be anticipated by having correct air back-up planning.

2. Low/out of air situation. It should be inexcusable to run out of air except where some fault develops in the equipment (case 60/79, case 9/79). It is suspected that many divers get into trouble in an effort to stay down as long as their buddy despite a warning "tightness" when taking a breath: unless they are close to their buddy they must often decide whether to try to reach him or make a solo ascent.

3. Demand valve faults. In three cases free-flow occurred, which would enable the diver to surface with air. In cases 52/79 and 3/79 the sensation of tightness was a clear indication of the need to surface while the DV still functioned. Case 60/79 is unfortunately too poorly documented to allow useful discussion.

TABLE 2

BS-AC DIVING INCIDENTS PANEL 1979 FATALITIES REPORT

Case	Skill	Mode	Depth	Water	UK A	Dive Unit	Incident Group	BS-AC Independent	
27/79	T	SC	15m	sea	A	3*	separated	I	*3rd ever dive, previous 12m, 27m; dive school; separated during descent; inhaled water?; instructor there.
29/79	Sn	SC	27m	F	UK	3*	separated	B	Rapid ascent (why?) left instructor with slower 3rd diver (pupil also).
48/79	T	SC	3m	F	UK	solo	alone	I	Trying out new equipment. Other divers to rescue, but resuscitation failed.
50/79	T	SC	surface	sea	UK	3*	separated	I	2nd ever use scuba, that day; surface snorkel to shore, low air, no vest. Instructor with other pupil.
31/79	Sn	Sn	surface	sea	UK	?	?	I	Hypothermia; boat dive.
60/79	?	SC	ascent from?	sea	UK	2	share/ separated	B	Out-of-air; failed buddy breath; faulty DV
77/79	?	SC?	?	sea	UK	3*	separated	I	No details
74/79	? (DO)	SC	45/27m	sea	UK	2	buddy	B	Aural barotrauma; ascent with scrap; unconscious suddenly at 27m; buddy inflated vest to raise.
61/79	?	SC	surface	sea	A	2?	separated?	I	Surface swim back to shore, in trouble, sank; no vest, no surface cover.
25/79	3rd	SC	ascent from 33m	sea	A	3*	?3	I	Confused while kitting-up; unconscious during ascent; buddy “rescue”.
91/79	3rd	SC	13m	sea	UK	3*	separated	B	“Buddies” continued, no notice his absence.
100/79	?	SC	surface	sea	UK	?	?	I	Ear trouble on descent; aborted dive; stress - induced CT entering boat.
113/79	?	SC	surface	sea	UK	?	?	?	Post dive snorkelling to shore; taken ill, died. Heart disease found.

T = Trainee Sn = Snorkel Diver 3rd = 3rd Class Certificate DO = Diving Officer
A = not UK SC = Scuba Diver B = BS-AC member I = Not BS-AC member

The other Emergency situations noted include three where the victim became unconscious while underwater: none, we may reasonably suppose, were diving strictly “by the book”. The cases, though worthy of fuller investigation, do not really bear on the question of Emergency Ascent training. In cases 80/79 and 24/79 it is presumed that the victims were overweighted, a fault indicating a need for better training in the true function of the ABLJ, or any other types of buoyancy aid.

Fatalities constitute a special and highly emotive section in the Diving Incidents register and are the chief reason for the introduction of diving instruction (why else would people pay to learn the simple art of breathing from a demand valve?). Of the twelve (12) scuba diver fatalities in the BS-AC report only one (60/79), already noted, has a place for emergency ascent. As details are lacking as to depth and whether the DV gave warning of malfunction, as also to the diver’s experience and training, evaluation must be postponed. In four cases it is apparent that the Critical factor was the poor control over inexperienced pupils exercised by their Instructors. The repeated reports of surface deaths should make the wearing of buoyancy vests a priority.

The Australian fatalities support the suggestion that inadequate (or nil) instruction and experience are common critical factors. In two cases SCUBA equipment was hired by persons inadequately trained in its use. The only really puzzling incident was case SC/78/5. It is presumed that this diver, though judged a good student and recently certificated, was in some manner ill at ease. Possibly the problem was related to buoyancy, ear equalisation, a leaking mask, or some other disturbing factor, and an irresistible air hunger developed, leading to a belief that he was short of air though in truth he had a full and functioning tank. The sudden loss of consciousness made him oblivious to the problems of Emergency Ascent procedures.

In Table 4 are examples of pulmonary barotrauma occurring under conditions no more dangerous than those to which Emergency Ascent training would expose divers. The blow-up (case E) would equate with an imperfectly controlled ascent such as would inevitably occur on occasion every year to some Instructor). Case B shows that in a stress situation even a rapid ascent with air readily available can result in an Air Embolism: cases C and F are cautionary tales for anyone thinking that pool training at least is absolutely

safe.

TABLE 3
AUSTRALIAN DIVING DEATHS IN 1978: BRIEF DETAILS

Case	Age	Incident Depth	Skill	Dive Unit From	Dive	Comment
BH/78/1	27	25 feet	5 years	alone	boat	Hyperventilation blackout: spearfishing.
BH/78/2	30	30 feet	experienced	alone	boat	Tangled in lobster pot's rope.
BH/78/3	19	surface	poor swimmer	separated	rocks	Subarachnoid haemorrhage.
BH/78/4	46	surface	?poor swimmer	alone	rocks	Rough sea, had new speargun he did not wish to drop.
SC/78/1	17	surface	NIL	alone	land	2nd use new bought scuba, seeking golf balls in dam; tangled in weeds.
SC/78/2	24	surface	inexperienced	separated	shore	Poor swimmer, choppy sea; used buddy's C-card to hire scuba; surface snorkel towards beach when low air after dive.
SC/78/3	21	50 feet	just C-card	separated	shore	Failed to resurface when separated from buddy on descent; tired by rough sea; low air; poor vis. at depth; NO vest on; contents gauge though used in training.
SC/78/4	22	25 feet	inexperienced	separated	boat	Hired equipment; 2nd diver was 1st scuba use! 3rd "instructed" both at dive; entry without fins; no vest; overweighted, so descent too rapid, ruptured eardrums; tried to ditch tanks but tangled in harness.
SC/78/5	21	40 feet	just C-card	3	boat	Lost fin on descent; demanded immediate buddy-breathing at seabed; soon failed; 'went limp', brought up by buddies; some response to resuscitation, but died later. NO attempt to drop weights, use vest, try to ascend.
SC/78/6	40	surface	trained long ago	separated	boat	No vest; surface swim to boat; choppy sea, after dive; no recent diving experience. Found floating minus all equipment. Very difficult to get into boat.
SC/78/7	27	120 feet	trainee	2	land	Dam dive, down lightly buoyed line; Instructor ashore, both divers inexperienced; buddy line; overweighted; too rapid rate of descent so ruptured drums; cold, dark, tangled in branches, No CO_2 for vest; valiant but unsuccessful attempt by buddy to help
H/78/1	27	50 feet	untrained inexperienced	separated	boat	Spearfishing, 10 ft. visibility; found dead,airline disconnected from DV.
H/78/2	44	9 feet	inexperienced ?	alone	boat	Clearing jellyfish from water inlet of fishing boat; hose parted at joint.

B. IS IT SAFE, DOES IT TEACH?

There is no such thing as total safety but there are actions where the likelihood of resultant morbidity is significant if the action is repeated sufficiently often. The greater the number of persons supervising and undertaking this ascent procedure the greater will be the chance that a summation of imperfections in techniques or anatomy will lead to an obvious incident. Work by Ingvar[5] and James6 has indicated that there will be many episodes of sub-clinical pathology for every severe case. And Dr Jefferson Davis has noted7 that of the 25 cases of Air Embolism he has treated, eight were sustained during swimming ascent training from 30 feet. It seems probable that cases will have occurred outside the catchment area of his unit8 so the true morbidity of such practice has yet to be established with any certainty.

Even should some training procedure be sufficiently safe it should also be subjected to the test of whether it achieves its objective of assisting the production of a safe diver. Dr Glen Egstrom was described9 the teaching concept of "learning curves". He has shown that it takes 17-21 trials before there is a plateau in learning, the "overlearnt" situation where the skill can be utilised without the necessity for conscious thought of every step in the procedure. He has also noted that one problem with, for example, teaching buddy breathing is that the pupils rarely achieve a facility such that they can breath together while thinking of swimming to the surface: rather they are swimming while thinking of buddy breathing. There is also a need to frequently reinforce the skill to prevent its loss. The proposed training ascents will be inadequate to inculcate any degree of true learning, and will be carried out in unrealistic conditions of having a fixed line and an adjacent instructor. Any reinforcement of the lesson is likely to be undertaken without the full precautions of the training situation, and it is unlikely that even the best instructors will have a "ready" recompression chamber at the surface at the test area. It is possible that a sense of confidence will be given to the pupils but this is a far different matter from imparting a useful survival skill. And many panic ascents have ended successfully despite the absence of prior ascent practice.

It is possible to quote and counter-quote supposed statistics concerning the value, or otherwise, of the inclusion of an out-of-air ascent from 30 feet in basic training courses. A

constructive way of obtaining a balanced and final discussion would be for there to be a wide and impartial collection of reports on diving occurrences where some serious situations seem likely to develop. It is hoped that this paper will show the value of collecting facts and then seeking to evaluate their lessons, and that the safety conscious clubs and organisations will take up the suggestion. "Project Stickybeak" seeks such reports and welcomes co-operation with all other interested persons.

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7. Davis J. At SPUMS Scientific Conference, 1979. *SPUMS Journal*. 1979 (3) Oct.-Dec: 5-10
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TABLE 4

CASE A (1-78 USN) A student making an orientation dive using MK5 air set at 15 feet for 5 minutes became dizzy 8 minutes after surfacing, staggering about. It was noted that his right eye did not react normally to light. He was recompressed Table 6A with complete relief. Breath-holding during ascent was probably cause of gas embolism. Age 23 years.

CASE B (13-78 USN) SETT Steinke Hood escape ascent by 27 year old man from 50 foot lock. Ascent to surface took 10 seconds. Between 1 and 2 minutes after surfacing he reported dizziness, then became incoherent. Immediately recompressed to 165 feet in RCC, where became coherent and dizziness cleared. Treatment Table 6A followed. Presumed breath-holding during ascent.

CASE C (15-78 USN) Using open circuit scuba in a pool 12 foot deep this 2nd class diver student was undergoing training. He had been swimming under supervision for 45 minutes at 10-12 feet when he returned to the surface and seemed to experience problems and went under water. He was brought back but again submerged, for about a minute. When pulled from the pool he had cardiac arrest. Multiple problems were encountered during his treatment, including pneumomediastinum and right pneumothorax. Later signs of hypothalamic dysfunction developed and he showed signs of hypoxic encephalopathy. His condition remained poor and after 11 days brain death was accepted and life support mechanisms were disconnected. It is thought that gas embolism caused cardiac arrest, resulting in water inhalation. Such cases, where a diver becomes unconscious within 15 minutes of surfacing, should be treated by recompression as air embolism victims.

CASE D (42-78 USN) This 29 year old UDT/Seal diver using closed circuit scuba was a member of a 2-man team practicing combat dives/sneak attacks. He experienced some moderate degree of dyspnoea while swimming on the surface but elected to continue with the series of dives. During the next 2 hours he made 3 or 4 combat dives to 15 feet and experienced a return of tight, constricted breathing which progressively increased to the point of having moderately severe pain, mostly across the front lower area of the chest and accompanied by the feeling of definite congestion and by the raising of bloody sputum when coughing. Diagnosis: Mediastinal emphysema caused by over-inflation of the pulmonary system. Breathholding is the probable cause of this accident. He should have aborted the series of dives when he first noted difficulty in breathing. The "can-do" attitude can do you in when diving.

CASE E (54-78 USN) This 22 year old EOD student diver made a training dive to 24 feet, working with a MK II life balloon. In error the balloon was over-inflated, taking the diver to the surface unexpectedly. Within 15 minutes of surfacing he reported to the diving supervisor with loss of equilibrium. At medical check he was noted to be displaying restlessness and to have muscular weakness in his left arm and leg. He experienced relief on Table 6A at 165 feet and symptoms ceased. Such recompression should be initiated with minimal delay, not even waiting for a full medical neurological check.

CASE F (46-79 BSAC) Trainee in 5 metre deep pool was refitting the aqualung for the first time, while the instructor watched while snorkelling above him. The trainee had trouble so the instructor dived down to tell him to come up. The trainee held his breath on ascent and "burst a lung", but does not seem to have been seriously troubled by this damage.

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3. Provisional Report on Australian Diving Deaths in 1978. *SPUMS Journal*. 1979 (2) April-Sept: 26-34.
4. *OPNAVINST 9940.2A* (Statistics for 1 Jan. 1978 through 31 December 1978).
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ADDITIONAL BIBLIOGRAPHY

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SPUMS Journal, 1978 (3) July-Dec also contained articles by Dennis Graver in favour of Emergency Ascent Training Practice, pp 7-13; GD Harpur's "New Approach to Out-of-air ascents", pp 14-17; Walker's report on the 1977 diving deaths, pp 25-27, and a pool incident by D McIvor, pp 21-22

SPUMS Journal April-June 1978 contains additional articles reference the subject, and an extensive Bibliography.

THE BIO-MEDICAL RESEARCH DIVER

Michael D Curley, PhD,
Lieutenant, MSC, USN,
Naval Medical Research Institute.

Navy divers completing 85°F warm water dives one week, then flying over 1,000 miles to take part in 41°F cold water dives the next week?

It does happen - particularly if the divers are participating in one of the biomedical diving research studies at the Naval Medical Research Institute. This past spring, research divers concluded human-performance evaluations of the one-atmosphere diving system (JIM) in warm water and one week later were at work in cold water investigating physiological and psychomotor performance. For the Navy diver who's looking for unusual and unique experiences, biomedical research diving may be the answer.

The Naval Medical Research Institute (NMRI)is located on the grounds of the National Naval Medical Center in Bethesda, Maryland. The Navy's largest biomedical research facility, NMRI has on board approximately 200 military and 200 civilian personnel. Its mission, assigned by the Secretary of the Navy, is "To conduct basic and applied research and development concerned with the health, safety, and efficiency of naval personnel." As part of NMRI'S effort to carry out its mission, a biomedical diving research program has been active since the early 1940's. Within NMRI, diving support for medical investigations is primarily furnished by the Hyperbaric Support Department.

Navy divers serve a three-year tour at NMRI; most of the billets are slotted for saturation divers. On board at NMRI in the spring of 1979 were 13 divers: 2 Saturation Master Divers, 5 Saturation Divers, 2 Divers First Class, 1 EOD Diver, 1 SEAL/UDT Diver, and 2 Diving Medical Technicians. When the new 1500-psi saturation system becomes operational later this year (*Faceplate*, Fall '77), the number of diver personnel will be increased fourfold. The operational testing and subsequent diving of this new system will provide a unique opportunity for the divers to be part of "state-of-the-art" system technology, and aid in pushing forward the frontiers of diving physiology and medicine.

The present contingent of divers at NMRI is called upon to perform a variety of tasks in support of bio-medical research, in addition to the usual duties associated with a diving facility. Divers at NMRI often are asked to volunteer for diving medical experiments, experiments which may demand the utmost in diver stamina and fortitude. For example, during the past year NMRI divers participated in studies evaluating commonly used drugs (*Faceplate*, Spring '79), cold water performance, flying after diving, heat loss in water, blood gas exchange, and diver/operator performance in the one-atmosphere diving system. The tasks NMRI divers perform in these studies are rarely pleasant; moreover, the studies may call for extensive physiological monitoring of diver performance via electrodes and probes under conditions of extreme environmental stress (eg. water temperature, fatigue). Successful biomedical research divers at NMRI exhibit patience in the face of lengthy and involved experimental procedures and a dedication to accomplishing the tasks in an exemplary manner. Without the cooperation and professionalism of the NMRI diver, applied biomedical diving research would falter.

Although no single investigation is typical of the experiments under way at NMRI, a study can be chosen to illustrate the tasks NMRI divers are called upon to perform. Recently, MRI(DV) Weaver participated in a study evaluating the effects of water temperature on physiological, cognitive, and motor performance by a wet-suited, scuba-equipped diver. During the experiment he completed 14 dives in water ranging from 77°F to 41°F. On each dive he performed tasks including top hatch transfer, tooker patch removal and installation, time estimation, learning and memory performance on an underwater response acquisition paddle, and torque wrench estimation. Before each dive ECG electrodes and temperature probes were applied; bottom times ranged from 30 to 50 minutes. The data gathered from this study will assist researchers in understanding the nature and extent of environmental stressors on diver performance. Once validated, this information will be passed on to the fleet with recommendations for appropriate action.

When not actively engaged in a research project, NMRI divers can be found conducting pressure and O_2 tolerance tests for US Naval Academy midshipmen and diver candidates, requalification dives for Naval District Washington MC and MSC officers, hyperbaric Vickers treatments for various disorders (eg. gas gangrene, bone necrosis), requalification dives for NMRI personnel, and recompression treatments for both military and civilian diving accidents. In addition, NMRI divers have the opportunity for travel. Among the TAD locations visited by NMRI research divers in the past year were Isle of Shoals, Maine; San Antonio, Texas; Panama City, Florida; and Columbus, Ohio.

What do the NMRI researchers think of the support provided by the research divers? The comments of Dr JM Walsh are illustrative: "NMRI divers do an excellent job for us. They are co-operative and highly motivated, despite numerous discomforts and indignities they must endure for reliable data to be gathered." The NMRI biomedical research diver fills a unique and important role in advancing our understanding of the effects of hyperbaria on the human body.

WE THANK THE SUPERVISOR OF DIVING, US NAVY, FOR PERMISSION TO USE THIS ARTICLE, WHICH WAS ORIGINALLY PRINTED IN FACEPLATE, SUMMER 1979.

OPINION CORNER: QUIS CUSTODIET CUSTODES?

Douglas Walker

Reading the article by Dr Michael Curley about his work using Biomedical Research Divers set me thinking about the responsibility of those running such investigations. Work involving risk of some sort to the subject is a necessary concomitant of seeking to advance physiological knowledge, and is unavoidable in the testing of new decompression procedures or the investigation of the course and the treatment of hypothermia, to mention two examples effecting diving medicine. Some seemingly extraneous facts influenced the decision to write, namely re-reading an article concerning experiments using rats[1], the publication of a book on CIA experiments[2], and the paper by Drummond Rennie[3] (Deputy Editor of the New England Journal of Medicine). The notation about the responsibility of all doctors to resist illegal and immoral acts on persons[4] was perhaps the stimulus to precipitate into print.

In the Royal Navy and the US Navy there are strict regulations to reduce the possibility for excessive enthusiasm on the part of those running or taking part in projects involving possible risk. In the RN there is an independent medical team with power to terminate any experiment/ project deemed to involve undue risk of morbidity, and the same holds true for the US Navy. However much work is undertaken in secret projects where, certainly in wartime, such rules do not apply. University and Grant sources also exercise control over experiments performed, though possibly are easier to mislead than are military scrutineers if Drummond Rennie's comments are taken as evidence. And certainly one has only to read some of the material that is published to be aware of the doubtful value of some work on the physiology of, say, the Dive Reflex.

As an example of the physiological work which could reasonably be considered as better discussed than performed one could read the paper by Hughes, Stein and Lynch, "Hopelessness-induced sudden death in Rats", which was a well designed series of rat drownings repeating the work of a famous and too revered physiologist, CP Richter. Apparently the original work was quoted by authority after authority in the best Medieval tradition without anybody questioning the work. These authors standardised the experiment and showed that it was not necessary to suppose that rats had to "give up hope" in order to explain that they drowned when submerged for a sufficient time. They showed that the bradycardia observed terminally was only while submerged and was known as the "dive reflex" by physiologists with a wider knowledge of their subject than most of those interested in ascribing feelings of Hope etc. to rats, seemed to possess. They showed that the LD50 for rats subject to an inescapable stream of water was a 6 psi jet pressure and that the rats barely able to remain with their nostrils at the surface tended to drown if they were denied the tactile input from their vibrissae. They also showed that rats suffered stress, and increased mortality, if they were handled sparingly, and tended to get entangled in ECG leads and drown. All this at the cost of watching 200 rats drown. Are such experiments justified?

But these were respectable workers fully believing in the worth of their experiments. Some may find it a little strange that one was a Postdoctoral Fellow and Instructor in Child Psychiatry and Paediatrics, the second was working for a doctorate in Physiology and that the third is a Professor and Director of a Psychophysiological Clinic who was interested in rats because of the pulse changes in patients in a Cardiac Intensive Care Unit. The paper raised no eyebrows when given at two symposia, before the Animal Behaviour Society and the American Psychological Association. As the work was performed to debunk ill-performed work by many who followed Richter, one can have reasonable doubts on the worth of much published work or the justification for such experiments. To be totally fair, the authors did observe that rats, like humans, can be resuscitated after "dry" drowning. Nothing they discovered was new, and the experimental design, though modelled apparently on the original work, was incapable of answering the question of their paper's title. But they knew this 200 rats earlier!

The description of the CIA's medical ventures, as detailed in John Mark's book "The Search for the Manchurian Candidate" and extracted in newspaper reports, shows that there are sufficient medical persons, and others, about who are only too willing to treat people like people treat rats. One may consider Shakespeare's words appropriate to the victims, who well could say of such arrogant people,

> "As flies to wanton boys, are we to gods,
> They kill us for their sport."
> (King Lear).

While it is to the credit of many that the CIA experienced trouble in obtaining trained medical help, it is discreditable that so many were willing to become involved and to publish heavily bowdlerised versions of what was occurring. It is stated that an eminent and respected figure, Dr Ewen Cameron (then director of the Psychiatric Institute at McGill University and one-time President of the World Psychiatric Association) was among those deeply involved in experiments which could be considered immoral and illegal by most. The book reports that many of the CIA experiments were performed on unwilling subjects with a ruthless disregard for accepted restraints of medical practice. In one study, for which it would have been impossible to attract college student volunteers seven prisoners were kept for 77 straight days on LSD. On another occasion LSD was given to unsuspecting persons, at least one of whom suicided. The response of Admiral Luis de Flores, the CIA's research chairman, to this tragedy was that it "would be an injustice" if the person responsible were to be reprimanded as this would hinder "the spirit of initiative and enthusiasm so necessary in our work."

As well as the problem of attracting researchers (sic!) there was that of finding enough guinea-pigs. The most convenient source was the flotsam and jetsam of the international spy trade and petty criminals who would be powerless to seek revenge. One of the project directors felt that only by testing subjects "for whom much is at stake" could he obtain reliable results. He called such tests "terminal experiments", as the subject's life was possibly at stake, a code name which should have alerted those in authority with any moral scruples. Dr Cameron is said to have used electroshock, undeterred by the screams of the victims. He is also credited with leaving one woman in a sensory deprivation box for 35 days. He died in 1967, much honoured by his peers.

So it seems that there may be a problem in that one cannot always rely on the official monitoring procedures to act efficiently. It is greatly to the credit of the American system that, in due time, the information was made public, something that would be possible in few, if any other, countries. As a fall back should the Establishment fail to act, who is to act as the "stirrer", who should we expect to make a stir about some animal or human experiment that seems to offend sense or morality? Those who look at TV reconstructions of Old Tyme Music Hall will know the answer. At the end of the evening, when every resource is being mobilised to ensure a loud and effective final rendition, the Master of Ceremonies lists the performers and concludes "but chiefly, YOURSELVES". Now you know where the buck stops!

References on Page 5.

CORRESPONDENCE

Alexander in his barrel

Sir,
I feel the Editorial in the SPUMS Journal July/ December 1978 contained an error in the opening sentence. It gives the impression that Alexander the Great did not have anything to do with underwater diving where I consider, from information that has come my way, that he did. I am not sure of the source, but a medieval artist has depicted Alexander exploring the "beeps" in a glass barrel. It is titled "Hazards of the Sea" and shows the problems Alexander the Great would have come across if he had gone diving. There is further information that has it that when he decided to capture the Island of Rhodes he decided on a frontal assault on the very well guarded city, which has the Colossus astride the harbour entrance. He is reputed to have sent in a team of snorkel divers to cut the moorings of the boats blocking the entrance to the harbour, this allowing him to sail straight into the centre of the harbour. Whether or not he did have anything to do with the underwater, at least he appears to have well known that it existed.

NOEL ROYDHOUSE (OCT. 1979)

Editor: It is good to hear from an actual reader of the Journal, even when he misunderstands what the Editor meant! As noted, Alexander would probably have been offered (associate) membership of the Society even though his posthumous claims of actual underwater time lack independent corroboration. As the artist credits the underwater environment with a somewhat remarkable flora and fauna it is possible that Nitrogen Narcosis was encountered even though not recorded directly. It is certainly admitted that The Ancients were up to performing every nasty activity in, on and under the water that their technology could support: but their scientists couldn't match those of the present day. Fortunately for Alexander, but unfortunately for us, there was no diving related incident to rejoice the scribes of his day, so his dive never made the pages of the Macedonian Diving News.

* * *

Dept. of Anaesthesia,
Christchurch Hospital,
New Zealand. 16 July 1979

Dear Sir,

I am indebted to Carl Edmonds for his most interesting discussion of underwater oxygen therapy for DCS. There are a number of areas of the New Zealand coast where the evacuation of diving casualties must pose considerable problems, with much delay in reaching treatment. There is interest, for instance, in establishing this emergency equipment in the Marlborough Sounds area of the South Island.

Whilst I go along with most of what was said, I cannot but express concern at the rather casual manner with which Dr Edmonds brushes aside the problems of hypothermia. This would be entirely contrary to my own experience. I would regard hypothermia as being the major limiting factor in the use of underwater oxygen therapy at water temperatures below about 15°C (and possibly as high as 20°C)). Has Dr Edmonds ever done a 45 minute oxygen decompression in 12°C water following a 200 foot helium dive? I have, and it is not a pleasurable experience, even for one as well endowed with natural insulation as I am.

As further support of my contention, I would like to make the following points:

1. Serious hypothermia may develop in less than one hour in the wet-suited diver. During shallow 5°C dives lasting about 40 minutes, the mean fall in rectal temperature of 15 fit young experienced scuba divers was 1.1°C (Davis, 1975). Several thin individuals in that experiment showed falls of over 2°C and two of them were removed from the water for safety reasons before completing their allotted tasks. In an unpublished study of similar wet-suited diving in 9°C water, I recorded an average fall in tympanic membrane temperature of 1.8°C. Even at 20°C a few thin individuals shower temperature drops of as much as 1.2°C during a 45 minute dive. Hayward and Keatinge (1979) have recently highlighted yet again problems of insidious hypothermia.

Against this data one has to place that on long duration submersible operations, highly trained naval divers were able to tolerate long periods of cold shallow submergence with stabilisation of deep body temperature at above 35°C. However, decompression accidents do not occur only in highly trained and motivated cold adapted military divers.

2. My next point is anecdotal and is in the form of a case report.

At the end of a day's diving during a research project off the west coast of Scotland, an experienced undergraduate diver volunteered to carry out a brief bounce dive to 31 metres to retrieve some equipment requiring overhaul. Water temperature was 11.5°C. He had been in the water 30 minutes, during which time he had performed a 31 metres dive lasting 9 minutes. He was on a life line and diver-to-surface communication. About 10 minutes into the dive the surface tender noted a sudden marked increase in his respiratory rate. The diver reported he was ensnared in some bottom lines and could not free himself. The standby diver had dekitted at this stage and it took about 10 minutes before he was in the water. By that time the diver had successfully freed himself and made an ascent to the 6 metre stop, where he had exchanged tanks. By then he had a total dive time of about 30 minutes to a depth of 31 metres. Because of the remoteness of the dive site, instead of carrying out stops of 5 and 5 minutes at 6 and 3 metres respectively, this was extended to 5 and 15 minutes as for a 40 minute dive to 31 metres. During the latter half of this, it required two support divers to assist him - one to maintain his station on the shot and one to hold his mouthpiece in place, as he was too cold to do either for himself. On surfacing he had to be lifted ashore and dekitted, as he was shivering violently and uncontrollably. Body temperature was not recorded, but later he stated that he had never been that cold in his life and thought he was going to die.

3. A further factor that must be taken into account is the influence of cold on inert gas elimination from the body. It is an old saw that cold increases the risks of DCS. Likewise the vascular responses to cold exposure reduce perfusion, including that to many tissues considered critical in the development of DCS. The continued activity of these vascular reflexes and indeed their progression during a long exposure (and 2 to 4 hours in addition to the dives precipitating the accident is long) in temperate or cold water must surely impair inert gas elimination and thus the effectiveness of underwater therapy.

With constant volume dry suits, this may not be a problem. I am aware of one New Zealand diver who has successfully self-treated a type 2 bend by recompressing on air back in the sea in a Uni-suit.

I believe the safety of underwater oxygen therapy in cold or temperate waters is not proven.

MICHAEL DAVIS
Special Anaesthetist

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Hayward MG and Keatinge WR. Progressive symptomless hypothermia in water: possible cause of diving accidents. *British Medical Journal*. 1979 (1): 1182.

(EDITOR: Dr. Davis raises the point that decompression sickness may not be the only danger, hypothermia being an ever present risk in many areas. However it should be noted that Dr Edmonds has proposed his system of in-water oxygen decompression as an exceptional option, not as a routine procedure. Anyone who enters decompression-requiring dive times should be prepared, not expect the oxygen tables to save him from himself. Dives to 200 feet on helium mixtures should only be made by specially trained dive units with the necessary backup. They should not be diving direct from the surface but from a bell, for safety reasons. The "experienced undergraduate" diver was making the classical solo dive without reserve diver ready, a fine and proven way to buy into trouble. Drs Davis and Edmonds will agree that it is best to arrange matters so that the equipment is available but not required).

* * * * *

COURSES IN UNDERWATER MEDICINE

The Diving Medical Centre will be running courses in Underwater Medicine in 1980 and 1981.

1. November 22nd to 29th 1980 Bay of Islands (New Zealand) with an optional week 29th November to 6th December 1980 in Tonga.
2. Honolulu, June 2nd to 16th 1981. First week in Honolulu, second week in the outer islands.

For further details contact:
Diving Medical Centre,
6 Hale Road, Mosman, NSW 2088

SUBSCRIPTIONS

Members pay $20.00 yearly and Associate Members $15.00. Associate membership is available to those neither medically qualified nor engaged in hyperbaric or underwater related research. Membership entitles attendance at meetings and the Annual Scientific Conference and receipt of the Journal/Newsletter. Anyone interested in joining SPUMS should write to the Secretary of SPUMS, Dr Christopher J Lourey, 43 Canadian Bay Road, Mount Eliza, Victoria, 3930.

SPUMS CONFERENCE 1980

The SPUMS Annual Scientific Conference and AGM 1980 will be held from June 20th to June 29th at Pulau Tioman (Malaysia) and June 30th to July 5th in Singapore.

The Keynote Speaker-Guest Lecturer will be Dr John Miller, Medical Director of the Hyperbaric Unit, Duke University, and Secretary of the Undersea Medical Society.

For further information contact Allways Travel, 168 High Street, Ashburton, Victoria, 3147.

PUBLICATIONS OF THE UNDERSEA MEDICAL SOCIETY

Emergency Ascent Training
15th UMS Workshop, December 1977.
RC Sampson and JW Miller
Price $4.00 including postage.

The Effects of Diving on Pregnancy
19th UMS Workshop, Nov 1978.
WP Fife
Price $3.00 including postage.

Treatment of Serious Decompression Sickness and Arterial Gas Embolism
20th UMS Workshop, January 1979
JC Davis
Price $3.50 including postage.

These are available from:
The Undersea Medical Society,
9650 Rockville Pike,
Bethesda,
Maryland, 20014
USA

Prices are in US Dollars and a bank draft should be sent with the order.

NOTES TO CORRESPONDENTS AND AUTHORS

Please type all correspondence, in double spacing and on only one side of the paper, and be certain to give your name and address even though they may not be for publication. Authors are requested to be considerate of the limited facilities for the redrawing of tables, graphs or illustrations and should provide these in a presentation suitable for photo-reduction direct. Books, journals, notices of symposia etc., will be given consideration for notice in this journal.

SPECIAL NOTE

The article "Drugs and Diving" (SPUMS Journal, April-September 1979) contained an extended extract from the chapter of the same title in "Diving Medicine" (editor RH Strauss, MD). This was not so indicated in the text, though Dr J Michael Walsh, who wrote the chapter, was given as a reference at the end of the paper. This error is regretted. Authors are advised of the need to give clear notice to the reader of direct quotation of material, and to avoid extended extracts of the work of others without prior written permission from the author of any such extracts.

DECOMPRESSION SICKNESS: BUILDING AN UNDERSTANDING

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A NMRI researcher discusses the kind of reasoning that has been used to design decompression schedules, and presents his own view of how well the various theoretical concepts agree with proven events in a diver's body.

Divers are well acquainted with the US Navy decompression tables. How these tables developed and how their development compares with the reasoning behind decompression tables of other navies and private organizations is not as widely known.

Decompression sickness (DCS) is a rare example of human disease in that prevention of the disease can be approached by the use of involved theoretical calculations. The theoretician follows several steps: first, he decides on the cause of the disease; he then breaks down the cause of the disease into aspects that can be solved separately; finally, he reassembles these partial solutions into a complete package that can describe the entire disease process and its prevention.

Decompression calculation procedures are thus developed from particular sets of ideas about events in the body that may cause the variety of DCS symptoms. Each set of ideas, whether based on fact, assumption, or guess, is known as a "decompression theory."

SEARCH FOR THE DCS VILLAIN

Possible causes of DCS, proposed within the last century, are listed in Table 1. When workers became stricken with DCS, or "the bends", during the caisson construction of the St Louis bridge in the 1870's, some doctors concluded that diver exhaustion was to blame. But simple physical exhaustion has failed to answer most of the questions raised by DCS, although exercise while under pressure still appears to contribute to it.

TABLE 1
POSSIBLE CAUSES OF DECOMPRESSION SICKNESS

1. Exhaustion
2. Blood cell aggregation/clotting
3. Fluid shifts
4. Chemical changes in blood vessels
5. Gas bubbles

More recently, several groups of diving researchers have based the prevention and treatment of DCS on drugs and on procedures that affect blood cells, blood vessel walls, or the movement of fluids among various spaces in the body. These researchers could be said to follow *a biological* approach to DCS prevention.

Today, most researchers follow a *physical* approach to DCS; that is, they believe that DCS occurs after the physical process of gas formation in the body. According to this belief, DCS can be avoided if the formation and growth of gas bubbles is avoided or, at least, minimized. Furthermore, this school of thought attributes the changes in blood cells, body fluids, and blood vessels to biochemical events that occur only after the bubbles appear.

Emphasis on the gas bubble as primary villain in DCS has encouraged researchers who are mathematically inclined to try to solve DCS problems without worrying about the complicated biological processes that underlie the disease (which is the usual mode of operation in medical research). The processes that describe how gases move through liquids and how bubbles form and grow in supersaturated liquids are fairly well understood. At least in simple physical situations, these processes can be described with precise mathematical expressions.

TABLE 2
ELEMENTS OF GAS BUBBLE THEORY ABOUT DECOMPRESSION SICKNESS

1. Rate of gas exchange:
   - Blood perfusion
   - Diffusion through tissue
   - Statistical
2. Symptom-provoking event(s):
   - Initial formation of bubble
   - Growth to critical size
   - Biology following appearance
   - Location

ELEMENTS OF GAS BUBBLE THEORY

Elements to be considered when one evaluates DCS bubble theories are detailed in Table 2. The major elements to be addressed are (1) the *rate of gas exchange* (ie. at what rates and in which locations does gas move in the body during a dive?), and (2) *the symptom provoking event(s)* (ie. what property of the gas bubble(s) causes DCS symptoms?).

Rate of Gas Exchange. Gas exchange rates probably depend, in a rather complicated way, on the properties of gas molecules as well as on the properties of body tissues. Gas transport is frequently described from two simplified viewpoints, the *blood perfusion model* and the *tissue diffusion model.* The more common blood perfusion model states that gas transport is limited by rate of local blood flow because the gas molecules can exchange very quickly between small blood capillaries and the tissue spaces near them. The tissue diffusion model states that blood can supply or remove gas quickly, so that the process of diffusion of gas molecules between or into tissue cells limits the overall rate of gas exchange. Evidence from laboratory experiments has not yet resolved which simplified approach applies to human diving. The final answer may lie between these two extremes; already, several theories contain mixtures of perfusion and diffusion elements.

Symptom-Provoking Events. The second element of any gas bubble theory requires that a decision be made on what makes bubbles "bad". For much of this century, attention was focused on the idea of bubble formation. The tactic in decompression schedule calculation was to avoid a critical ratio of inert gas supersaturation (that is, the ratio of the dissolved gas partial

pressure in the body to the hydrostatic pressure at the diver's particular depth). This consideration was presumed to prevent bubble formation, and it is the basis for the present US Navy tables. In recent years, however, evidence has accumulated that during many dives, divers' bodies contained gas bubbles without the divers noticing any DCS symptom. Therefore, several theories allow for the formation of bubbles but try to prevent the bubbles from growing to a certain critical size, or deforming certain tissue structures, or exceeding a certain number.

TABLE 3
DECOMPRESSION TABLES CALCULATED BY DIFFERENT GAS BUBBLE THEORIES

Source	"Tissues"	Gas Rate	Bubble Event
Haldane (1980)	5	Perfusion	Formation
US Navy (Workman, 1956)	6 - 9	Perfusion	Formation
Royal Navy (Hempleman, 1967)	1	Diffusion	Formation
Swiss (Buhlmann, 1969)	6	Perf/Diff	Formation
"Thermodynamic" (Hills, 1966)	2	Diffusion	Growth
Hawaii (Yount, 1978)	1	Perf/Diff	Number

WHY SO MANY BUBBLE THEORIES?

Gas theories for calculating decompression tables are shown in Table 3. At the risk of over simplification I have listed for each theory (1) the number of "tissues" (mathematically distinct sets of gas exchange rates); (2) the procedure for calculating rates depending upon the choice of blood perfusion or tissue diffusion models, or a combination of both; and (3) the choice of bubble event that leads to DCS. Obviously, theories are available to cover most of the possible combinations.

The reasons for having a wide selection of gas bubble theories of DCS arc simple: very little experimental information is available for deciding which set of assumptions matches the events occurring in a diver's body. The gaps in our knowledge exist for many reasons. The perfusion-diffusion controversy still rages despite evidence that both assumptions are incorrect. We still do not have methods to detect or measure sizes of bubbles in most parts of the body. In addition, pain, the most common symptom of DCS, is difficult to describe biologically much less mathematically. Finally, in spite of the inherently low incidence of DCS during thousands of dives using common decompression schedules, we cannot eliminate the possibility that chance alone may account for the differences in safety reported in dives using different decompression tables. Thus, most "practical" diving experience does not contribute to our understanding of which theories work better than others.

Several projects at the Naval Medical Research Institute are aimed at plugging these gaps in our knowledge. Commander John Hallenbeck has been able to follow the progression of biological events in spinal cord DCS that occurs after bubbles become visible. Commander Thomas Berghage has amassed a large body of information on the procedures that lead to serious symptoms of DCS in small animals - information that will serve as a reference for predictions from theoretical calculations.

Commanders Edward Flynn and Kristopher Greene are preparing to measure gas exchange in divers performing at different levels of exercise. Dr Louis Homer is developing the mathematical formulations necessary to compare special combinations of perfusion and diffusion gas exchange conditions with careful animal and human measurements. My colleagues and I are measuring gas exchange over prolonged periods in many tissues of animals, and we have developed a statistical description of gas exchange rates that avoids choosing between perfusion and diffusion assumptions.

CONCLUSIONS

Decompression theories are not scientific theories in the sense of the law of gravity; rather, they are mathematical predictions based on unverified assumptions.

Decompression theories do provide calculation methods for summarizing the experience of divers; they also provide starting values for developing new schedules.

Theoretical calculations of new decompression schedules usually cannot be accepted immediately; they are revised to provide adequate safety.

It remains for researchers to establish how fast and where gas exchange occurs and the specific processes through which the gas leads to DCS.

WE THANK THE SUPERVISOR OF DIVING, US NAVY, FOR PERMISSION TO USE THIS ARTICLE, WHICH WAS ORIGINALLY PRINTED IN FACEPLATE, SUMMER 1979.

FIFTH ANNUAL CONFERENCE ON THE CLINICAL APPLICATION OF HYPERBARIC OXYGEN

The Fifth Annual Conference on the Clinical Application of Hyperbaric Oxygen is scheduled for Wednesday through to Friday, 11-13 June 1980.

For details contact:
Michael B Strauss, MD, Chairman Program Committee,
Fifth Annual Conference on the Clinical Application of Hyperbaric Oxygen,
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IN MEMORIAM

SPUMS MEETING
Canberra 15 March 1980

It is with regret that we record the stillbirth of the projected SPUMS meeting scheduled for Saturday 15 March 1980 at the Royal Canberra Hospital. The petrol tanker drivers' strike in NSW forced cancellation.

MEDICAL PROFILE OF THE WOMAN SCUBA DIVER

Susan A Bangasser

WE ARE INDEBTED TO NAUI FOR PERMISSION TO REPRINT THIS PAPER.

ABSTRACT - The Medical Aspects of Women Divers Survey was widely distributed and the response by women scuba divers was tremendous. Data will be presented covering the following questions: What is the overall physical condition and diving practices of women divers? Are women more susceptible to decompression sickness than their male colleagues? Does the birth control pill affect women's susceptibility to decompression sickness? Have women scuba divers dived during pregnancy? If so, were there any problems the mother or baby experienced?

The Medical Aspects of Women Divers (MAWD) Survey was distributed to women scuba divers in an attempt to gather information on their health, effects of menstruation on diving, methods of birth control, susceptibility to decompression sickness, effects of diving on pregnancy, and effects of pregnancy on diving. There were around seven hundred responses to the survey, coming from the United States, many Caribbean countries, Australia, Singapore, Guam, and South America. This paper will present the information and analysis gathered from 610 surveys. An additional 72 surveys were analyzed under the Pregnant Diver category.

HEALTH AND DIVING ACTIVITIES OF WOMEN SCUBA DIVERS

The women who responded to this survey ranged in age from 16 to 63 years; the average respondent was 29 years of age. This compares to a median age of 28.1 found by Skin Diver magazine's "1977 Reader Survey" (90.5% of their respondents were male). These women divers were in "good" health, since 99.7% indicated that answer in the survey. The additional 0.3% were in fair health, and none were in poor health. Even a 63 year old respondent, who had two mastectomies, was still diving, and was in fair health.

The women respondents had been diving between four months and 17 years, with 4.5 years as the average. Most of the women were active divers. The breakdown of the diving activity is as follows:

Dive once a week (minimum)	34.2%
Dive once a month	18.2%
Dive six times a year	19.2%
Dive seldom	2.1%
Dive on vacations only	20.0%

There was a variety of certification levels achieved by the women, and the breakdown follows:

Basic Scuba Diver	39.5%
Sport Diver (Open Water Certification)	14.4%
Advanced Diver	19.5%
Divemaster	1.6%
Assistant Instructor	8.2%
Instructor	16.7%

In Skin Diver's "1977 Reader Survey", 91.7% of the respondents were certified as Basic Divers, and 26.2% had Advanced certifications because of its means of distribution - handed out at several underwater conferences, printed in NAUI News (an instructor association newsletter), and printed in Undercurrent.

THE MENSTRUAL PERIOD

One of the questions asked by many women divers is, "Can I dive during my period?" Another is, "Will I attract sharks?" This section of the MAWD Survey attempts to gather information on diving practices of women during their menstrual period and their feelings about the issue. Women were asked how they felt during their menstrual period, and 85.6% felt normal, 13% felt ill (cramps or nausea), and 1.4% felt incapacitated. Some women claimed to feel worse on the first day. Most of the women have dived at least once during a period (93.9%). Some of the remaining 6.1% did not dive, only because the opportunity had not presented itself yet. Even though the majority dived during their period, many of them still worried about attracting sharks (26.2%). The consensus of medical people who have written on this subject is that women divers would probably prefer to wear internal protection, such as tampons; that sharks are attracted to fresh blood, not hemolyzed (old) blood; and that a women diver can go ahead and dive during her period if she feels well. One of the respondents claimed she used to worry about attracting sharks, but then she realized her husband's nosebleeds did not attract them, so she quit worrying about it.

Women had a wide range of comments regarding the effect of menstruation on diving. Some had less energy, some were colder on dives. One woman who had no problems with her period was instructed not to dive at that time of the month. However, one claimed she had less cramps if she dived during her period. Another had more energy and even had her best times in competitive swimming during her period.

Diving also affected the menstrual cycle in a variety of ways. For some, diving delayed the onset of menstruation; one women even would skip a period. For another women, if she had several days of diving, the period would be advanced by as much as a week. Another had shorter and more irregular periods since diving. Most of the women made no comments about any effects of diving on their periods. From the few who did comment, it is apparent that diving did not affect everyone in the same way, and that individual difference prevailed.

The maximum depth obtained by women during their menstrual period ranged from 12 to 210 feet, with the average maximum depth of 85 feet. The average depth dived to (ie. the most common) ranged from 10 to 130 feet, with an average of 51 feet. Any problems that occurred with decompression will be discussed under the heading of Decompression Sickness.

BIRTH CONTROL METHODS

The majority of women (80.8%) have used some form of birth control since they began diving, and 65.4% are currently using birth control of any type. The methods break down into the following categories: 45.9% are using birth control pills, 18.4% use IUD's, 20.2% use diaphragms, and 15.5% use other methods. Another 64.6% of the respondents at one time used birth control pills, although they are not currently doing so. The percentage of divers who are currently or at any time have used birth control pills is 61.8%. Over 32% have used their present method of birth control for at least five years. The use of birth control pills was tabulated because of the possible link between the pills and increased susceptibility to decompression sickness. The speculation is that birth control pills cause a microsludging (slowing down) of the circulation, which can increase chances of the bends. The effects, if any, of birth control pills on decompression sickness of the respondents, will be discussed in the next section.

Use of birth control pills has affected 52.7% of the respondents. The side effects suffered include: 32.4% had lighter periods, 24.6% gained weight, 10.5% suffered headaches, 7.1% had nausea, 4.4% had heavier periods, 3.7% had high blood pressure, 1.8% had blood clots, and 15.9% suffered from other symptoms. When asked if their present method of birth control changed their diving frequency or pattern, 97.8% responded negatively. Of the 2.2% whose diving was altered, 45.4% did more diving, 27.3% did less diving, 9.1% did shallower diving, 18.2% had other changes, and none did deeper diving.

DECOMPRESSION SICKNESS

This survey attempted to answer these questions: Are women more susceptible to decompression sickness than their male colleagues? Are women more susceptible to decompression sickness during certain times - during their menstrual period, while using birth control pills? From the information given on number of years diving and diving activity, each person's estimated total number of dives was calculated. From the 649 divers used in this analysis, there were 88,028 estimated dives. Twenty nine cases of decompression sickness were reported, giving a 0.033% incidence. Many cases of the bends were not treated, but if decompression sickness was suspected from the symptoms and the history of the dive(s), the case was listed as positive bends. Cases of skin rash were considered positive also, but not skin itch only. There were three cases of decompression sickness obtained while in hyperbaric chambers and one on a Tektite saturation dive, but these were not included in the evaluation of sport divers.

In order to compare this incidence rate in females to a rate in males, portions of the survey were sent in a newsletter that reaches instructors, assistant instructors and divemasters in Southern California. Then the data on women instructors, instructors and divemasters (hereafter called the instructor group) was separated from the other women respondents. The women instructors made an estimated 44,154 dives, and 10 cases (three women were bent twice) of decompression sickness were reported (0.023%). The male instructors made 43,126 dives, and three cases (0.007%) of bends were reported. (Two other cases of decompression sickness in the male group made on mixed gas diving were not used in this analysis). The females had a 3.3 fold greater incidence of decompression sickness. This incidence in females compared to males is statistically significant by Chi^2 at the 0.025 level.

The female instructor group made about half the estimated number of dives for the female respondents, yet had about a third of the cases of the bends (incidence of 0.023%). The incidence of decompression sickness among the female divers basic through advanced (no instructors) is 0.043%. This difference in incidence is significant by Chi^2 at the 0.100 level. The data is summarized in Table 1.

TABLE 1
INCIDENCE OF DECOMPRESSION SICKNESS

Group	No. of Dives	No. of Cases	Percentage of Incidence
All women	88,028	29	0.033
Women - Basic-Advanced	43,874	19	0.043
Women - Instructors	44,154	10	0.023
Male - Instructors	43,126	3	0.007

One section of the survey asked a series of questions answered by the women relating to their diving histories while using birth control pills and/or while not using the pills. Altogether, 63.5% of the women have made a decompression dive at one time in their diving history. For the male instructors, 70.2%, and for the female instructors, 60.7% have made decompression dives. The women who made decompression dives while NOT taking birth control pills (39.6%) had an incidence of 3.9% of the divers having had decompression sickness. This and the following numbers were obtained by dividing the number of people who have had decompression sickness by the number of people who have made decompression dives. The numbers are not related to the diving activity since the number of dives under each condition is unknown. Another 2.2% of the women, while not on the pill, had decompression sickness on a NO decompression dive. Twenty-two and seven-tenths percent (22.7%) of the same group had nitrogen narcosis. The deepest depth achieved by women not on the pill averaged 115 feet, while the mean depth averaged 55 feet.

The same questions were answered by women who related the facts of their dives while using birth control pills. The women who made decompression dives (31.9%) while on birth control pills had an incidence of 3.7% of the divers having decompression sickness. Another 1.3% of the women while on the pill had decompression sickness on a NO decompression dive. Also 43.8% of the women in this group have had nitrogen narcosis. The deepest depth

TABLE 2

PERCENT OF WOMEN WHO HAVE HAD THE DECOMPRESSION SICKNESS UNDER VARIOUS CONDITIONS

	DECOMPRESSION DIVES			NO DECOMPRESSION DIVES		
Condition	No. of Divers	Percent of Divers	Percent Bent*	No. of Divers	Percent of Divers	Percent Bent*
Menstruation	131	23.2	3.9	497	88.8	1.2
On the Pill	106	31.9	3.7	301	49.3	1.3
NOT on Pill	179	39.6	3.9	454	74.4	2.2

* If a diver was bent more than once, she was only counted once

achieved by women while using birth control averaged 112 feet, and the mean depth averaged 57 feet.

A similar set of questions were asked of the women about their diving activities during their menstrual period. Of the 23.2% of the women who made a decompression dive during their menstrual period, 3.9% have had decompression sickness. An additional 1.2% have had the bends on a NO decompression dive. A summary of this data is in Table 2.

It appears that the percent of women who have had decompression sickness on a decompression dive under the studied conditions (during menstrual period and on birth control pills) does not differ from the percent achieved by women not on the pill. The cases of decompression sickness in the menstrual category are also accounted for in the "Pill" and "No Pill" groups. The percent of women who have made NO decompression dives and subsequently were bent is slightly higher in the "No Pill" category, but this difference is not significant by Chi.[2]

From the information on age, height, and weight, most of the women (80%) who have had decompression sickness appear to be normal or less than normal weight for their height. (This opinion is based on the following technique: 5 feet = 100 lbs, add 5 pounds for each additional inch ± 10 pounds). For the surveys that included a question on age (one group was printed without questions on age, height or weight), the ages ranged from 21 to 52, with the median and the average age of 31 years. The ages of the women bent more than once ranged from 23 to 52 years. The water temperature ranged from 40 to 80 degrees for the women who have had decompression sickness.

The information provided by the MAWD Survey indicates that women have a greater chance of having decompression sickness than males. Also, a diver with more training (the instructor group) had less incidence of bends per dive than the group of women certified basic through advanced. A factor that enters the comparison of "instructor group" to "non-instructor group" is that for active instructors (that is, ones who are teaching, not just certified), possibly a higher percent of their dives would be at depths less than 40 feet, since they would be student training dives. This factor could be, in turn, counter balanced by these same active teaching divers pushing the tables, because of the necessity to make several dives a day either for training divers or for serving as guides. These numbers do not consider human errors in judgement. The percent of divers having decompression sickness while diving during their period, on the pill, or not on the pill, appears to be almost equivalent. The numbers will be compared on a per dive basis at a later time.

THE PREGNANT DIVER

The safety of scuba diving while pregnant is a problem, because now two lives must be maintained. No real information has been available to help the female diver decide whether to dive or not. Because of the lack of information, most medical "authorities" have recommended either not diving or keeping the dives above 33 feet (the depth where the pressure in sea water is two atmospheres). Recently, a study on pregnant sheep was conducted at Texas A & M University by graduate student Clifford Simmang and Dr William Fife, a physiologist. This study indicates that women who are pregnant should dive above 60 feet, if they choose to continue diving. The MAWD Survey studied the responses of the pregnant diver and found the following results.

A total of 72 respondents claimed to have scuba dived while pregnant. This is 10.5% of the total number of women who answered the survey, and 72% of the number of women who have become pregnant since taking up scuba diving. Many women began diving after their children were born, and a number of women had abortions to terminate pregnancy. These women were not included in the results. If a woman made a dive(s) before knowing she was pregnant, and subsequently decided to cease scuba diving, she was included in the results. Since the earliest that a pregnancy can be determined is six weeks, the women who quit diving by the second month were generally those who decided that pregnancy and diving don't mix. A breakdown of the number who ceased diving is found in Table 3.

The reasons for discontinuing diving were usually one of these two: The first is that many women did not know if there was any danger to the foetus and discontinued early, usually the first or second month. The next reason for discontinuing diving was that the wet suit no longer fitted. These divers discontinued around the fourth or fifth month. Nausea in the first couple of months of pregnancy kept some divers out of the water.

TABLE 3

CONTINUATION OF SCUBA DIVING BY PREGNANT WOMEN

Trimester	Number Diving*	% Diving
First	25	39
Second	26	41
Third	13	20

Month	Number Diving*	% Diving
1	10	15.6
2	4	6.2
3	11	17.2
4	10	15.6
5	11	17.2
6	5	7.8
7	6	9.4
8	0	0.0
9	7	10.9

* *Eight women were still pregnant and had not discontinued diving yet. They were not counted in this part of the analysis.*

The women in this part of the study had been diving anywhere from six months to 17 years. The median number of years diving (number in the middle of the range) was six years, while the average was eight years. The age of the respondents at the time of the survey ranged from 21 to 46 years, with a median age of 30 years and an average of 29.6 years. The 46 year old respondent delivered at the age of 45, dived in the water above 50 feet, and discontinued during the fourth month. She and her baby had no apparent problems.

Forty-one percent of the respondents were certified as basic scuba divers, 14.5% were instructors, and the remaining had intermediate levels of certification. Two women learned to dive while pregnant. The activity of the divers before and/or after pregnancy compared to diving during pregnancy is listed in Table 4.

TABLE 4

PERCENT DIVING ACTIVITY BEFORE AND DURING PREGNANCY

Activity	Before/Between Pregnancy	During Pregnancy
Once a week, minimum	22	20
6-12 times/year	49	18
Vacations only	25	34
Seldom	4	28

Thirty-nine and four-tenths percent claimed that they maintained the same level of diving activity during pregnancy. Some, therefore, did not alter their diving habits. The number of women who dived at least once a week remained fairly constant (see Table 4). Many of these women dived in warm water and worked at resorts as instructors or tour guides. Many women dived during pregnancy because they were going on vacation, which for a diver means clear, warm, inviting water. Some of these respondents have been classified as discontinuing diving in, for example, the fifth month, but in reality only dived during that particular month while on vacation. The “seldom” category increased a great deal, as expected.

The potential problems associated with diving during pregnancy includes the possibility of the mother and/or the foetus getting decompression sickness. Nitrogen bubbles in the developing foetus could pose serious problems. If the mother gets decompression sickness (the bends), she may be treated with high pressure oxygen, which can present another problem for the foetus (retrolental fibroplasia). Five of the respondents made decompression dives while pregnant. However, no pregnant diver had decompression sickness. The maximum depth obtained by the pregnant divers ranged from 12 to 180 feet, with a median of 60 feet. The average depth ranged from 10 to 100 feet, with a median of 40 feet.

The temperature of the water dived in ranged from 40 to 80 degrees, with the most dives made in 70 to 80 degree water. Women did not avoid diving with wet suits, since 48% wore wet suits while pregnant. However, fitting into the wet suit was one of the problems contributing to the decision to discontinue diving until after delivery.

The babies delivered by the pregnant divers were all “normal” according to their mothers. One baby was underweight at birth. The male babies out-numbered the females 61% to 39%. The complications that occurred during pregnancy included one premature birth, one septic abortion (caused by an accident not diving related), and two miscarriages. (One of the women had four miscarriages; two prior to learning to dive, and two more since diving). The rate of spontaneous abortion for the general public is around 20%, and the rate for the respondents was less than 3%. There were seven Caesarean sections (12%). This procedure is becoming increasingly popular and the average rate is between 10% to 15% for the general public. All but one woman continued to dive after delivery. Fifteen women dived during more than one pregnancy.

Since the author is one of the seven respondents who dived through the ninth month, I cannot resist deviating from the numbers provided in the rest of the paper and getting into personal opinion for the pregnant woman considering diving. This is not the time to learn to dive. For the experienced diver, I recommend taking things a little easier - make one dive a day, avoid difficult surf, use common sense. I recommend that the pregnant diver stay in less than 33 feet (practically speaking, don’t go deeper than 30 feet - your depth gauge may be off by three feet anyway). I feel that scuba diving is a great physical and mental conditioner, but common sense must always prevail. I recommend that a pregnant instructor not be the only instructor with her students in open water. Instead, she could actually serve as an assistant; it may be difficult for her to provide a complete rescue by herself, should one be needed. If a woman does not feel well, for example, nauseated, cramps or whatever, do not go diving. Remember, you got into the sport in the first place to enjoy

yourself. The respondents reported no unexpected mishaps or problems (even the deep or decompression divers), but I encourage the pregnant women to use good diving prenatal care.

There is a problem for the woman who dives the first six weeks of pregnancy, because she may dive deeper than desirable, not realizing she is pregnant. The only guide here, is if a woman has discontinued birth control and plans to have a family, to begin diving shallower. This may mean a lot of shallow diving for some, but a few deeper dives can fit into your schedule. Once you have had your period, and it is over (usually this means you are not pregnant, but not always) this would be the time for any "deep" dives you may wish to make. Dive shallow once ovulation or conception could be possible.

The Medical Aspects of Women Divers Survey has attempted to provide a medical profile of the woman scuba diver. The results of the survey have indicated several interesting points in the areas of diving during the menstrual period, susceptibility to decompression sickness, and diving while pregnant. Hopefully, the results presented in this paper will be the beginning of many areas of further exploration.

ACKNOWLEDGEMENTS

I would like to thank my mother, Mrs Lillian Andretta, for tabulating the results of the survey. I would also like to thank the National Association of Underwater Instructors for printing and distributing the survey, and Undercurrent for their printing of the survey.

MEDICAL DEFENCE UNION REPORT 1979

The following two cases are reprinted by kind permission of the MDU, whose annual report reminds doctors that misadventures can be nasty for them as well as their patients.

a. Hyperbaric Oxygen Blindness

A 42-year old man receiving hyperbaric oxygen therapy in 1971 for scrotal clostridial infection became permanently blind. His claim alleged that he was given too much oxygen and that the treatment was continued after he complained of visual disturbance. After a three week trial in 1978 the judge found for the plaintiff and approved damages of £65,000. This was shared between the two defence societies involved and the area health authority. On legal advice no appeal was made.

The judge found that the plaintiff, although at times in a confused state, complained to nurses, technicians and doctors about his eyes. The judge said that staff must pay MORE attention to complaints from confused patients and to comments from their relatives. He found that the plaintiff had gone blind during the last hyperbaric session, for which there was no clinical justification. For the defence alternative causes for the blindness were advanced but rejected. During the trial the clinical notes proved a central feature but missing blood pressure records were an obstacle.

Some familiar lessons are to be learnt from this action. Long intervals may elapse between incident and trial. Good, clear, accurate, legible and identifiable notes are vital. They must be preserved for the recommended period: protests about storage problems pale into insignificance when compared with the difficulty of defending an old case without contemporaneous records. In a multidisciplinary case lines of communication must be clearly understood and used. The law places a greater duty of care on doctors and others in management of confused patients or those with language difficulties. The plea of unforeseeability of complications may not succeed: the defendants were held liable even though there had been no previous report of blindness following hyperbaric oxygen. *(Editor: except neonates).*

b. Gas Gangrene

A 21-year old footballer sustained a compound fracture of the right tibia and fibula. A senior house officer, a member of another society, sutured a small laceration on the back of the calf and prescribed Velosef because of possible penicillin sensitivity. Under general anaesthesia a Denham pin was put through the calcaneum and the leg was placed on 14 lb. traction. The compound wound itself was small and presented no cause for alarm.

When the orthopaedic surgeon saw the patient for the first time next morning he noted that the lower leg was rather more swollen than was to be expected from the history and the nature of the injury. He also noted that shortly after the man's arrival in hospital he developed a temperature of 39.5°, but that during the ensuing two days he had become afebrile, suggesting that if there had been an infection it was under control with antibiotics.

When the consultant saw the patient again on the fourth post-operative day his temperature was 39.0° and there were large black blisters, some of which had burst and released an unpleasant smell. It was then that for the first time gas gangrene was suspected. There was crepitus in the lower leg at the level of the compound wound. X-rays showed gas in the tissues. After consultation with the bacteriologist it was decided to give intramuscular penicillin despite the history of allergy. There was no untowards result. He was also given anti-gas gangrene serum, but the following day it was apparent that the gangrene was spreading alarmingly. He was referred to another hospital for hyperbaric oxygen, but despite this he had to undergo below-knee amputation.

Solicitors acting for the patient sought disclosure of the clinical notes and obtained independent expert advice. As a result a claim was intimated alleging negligence in that gas gangrene should have been diagnosed earlier on the basis of radiographs, the temperature, the discolouration and blistering of the leg and the patient's general condition. It was also alleged that he should have been referred earlier for treatment with hyperbaric oxygen. The member agreed with the Union's view that the claim could not be successfully resisted and settlement was eventually effected for £26,000, to which the SHO's society contributed 25 per cent. Costs of £2,074 were also paid.

NON-FATAL SHARK ATTACK: A MEMORABLE QUALIFYING DIVE

The victim was a diving school pupil on the final sea dive of his course. There had been showers earlier in the day but these had rolled over, leaving the day overcast and a brisk southerly breeze. There were five students on the last day of their course and they had just completed a successful dive from the dive boat in good visibility conditions off a rocky islet. There were two qualified divers in the boat who had been diving with them, and two of their course instructors. To complete their course they were required to swim 500 metres in the sea without equipment, and this was arranged to take place as they returned to the beach. It was a necessity rather than a pleasure swim as it was cold both in the boat and in the water and they were swimming without wet suits or any equipment.

The five pupils started their swim with one of the instructors accompanying the two slowest swimmers and the other remaining in the boat. Due to differences in swimming speeds two of the pupils reached the beach while the third, the victim, was only three quarters of the way there. The boat was at this time between him and the last three swimmers, 70 metres off the beach. Suddenly the victim called out “Quick, something has bitten me!” and threw up his hands.

The instructor in the boat saw the water swirl around him but for some moments didn’t realise that anything serious had occurred. Then the swimmer called out “SHARK!” and it was immediately appreciated that matters were urgent, so the boat was accelerated to the spot where the victim was floundering. The victim was rapidly hauled aboard, helped also by one of the swimmers who had courageously swum out from the beach. The injuries to the right thigh looked dreadful to his rescuers, the wound edges having separated along a seven inch gash running diagonally from inside his leg to just above his knee, with several deep bloody gashes below the main wound. “It looked red, ragged and ghastly with the torn flesh ripped open displaying sinews and veins. It didn’t appear to be bleeding too much.”, was the report of one witness.

A quick decision had to be made: to reach the beach quickly but minimise the movement of the victim. The attack occurred only 25 - 30 metres off the beach so it only took a few seconds to get there. He was carefully lifted from the boat and placed above the water line. A pair of long john wet suit trousers were quickly found and used as a tourniquet. The next decision was whether to collect the three remaining swimmers or whether to immediately go to the hospital. Lest the shark attack again, the remaining swimmers were retrieved by the boat and then one of the instructors ran up the beach and hurriedly drove to the hospital to summon aid. The remaining divers covered the victim with dry towels and gave him comfort and reassurance while help was awaited.

The staff at the hospital reacted calmly and rapidly to this unexpected emergency and a doctor and the ambulance soon reached the beach. After a brief initial assessment examination the doctor set up a drip. The victim was shivering from the shock of his experience and looked pale and weak but had surprisingly not lost a great deal of blood. It was noted that fortunately the main artery had not been cut. Seeing the intravenous needle inserted nearly produced casualties among the spectators! The victim was now judged fit to be transported to the hospital.

The medical report states that there were no shark teeth left in the wound and that the bite was of a “token nature” (for a shark!), the shark luckily not having closed its jaws or shaken its head to tear flesh loose. The wound consisted of many small punctures from the teeth, which along the lower thigh were joined and in places extended as deep as the quadriceps muscle, which had its superficial fascia covering severed in several places. No major vessels or nerves were damaged. Surgical care resulted in minimal scarring and no permanent disability.

It was estimated that the shark was probably 9 - 10 feet in length, though it was not actually seen. During his recovery in the hospital the victim was visited by his friends and presented with a shark tooth on a chain, a thoughtful gesture he soon appreciated!

COMMENT: It is excellent that in a totally unexpected emergency everything was done in the advised mode. This minimised the shock and could, had the damage been more severe, have been critical to the outcome. Thanks are due to the divers and doctors involved for permission to use their reports.

DANGEROUS MARINE LIFE AFFECTING SWIMMERS AND SURFERS

Tony Edmonds
(Beach Superintendent, Warringah Shire Council, NSW)

The Warringah coastline stretches for 32 kilometres, from Harbord Beach in the south to North Palm Beach in the north. The twelve headlands enclose eighteen beaches patrolled either for the full surfing season (7 months) or the Christmas holiday period (6 weeks) by Council employed Beach Inspector-Lifeguards.

During the 1978-79 season an estimated 2,500,000 people used these beaches during the duty hours of the Inspectors. Of this number the Inspectors treated 6003 for first aid, had 157 taken to hospital and resuscitated 7 (5 successfully).

Approximately 80% of the first aids were the direct result of dangerous marine life. For the Inspectors this particular danger is generally limited, here in Sydney, to sharks, stingrays, blue ringed octopus and marine stingers. The former, being the exception rather than the rule and the latter causing the most concern.

The marine stingers, and the most common variety experienced by the Inspectors is the “bluebottle”, are most prevalent during the months of December, January, February. The strong easterly winds sweep them towards the shore in their thousands causing on a number of occasions beaches to be closed for swimming until they disperse.

The degree of severity of the sting depends upon the skin of the swimmer and the degree of contact. It has been found that persons with light dry skin are affected the most. For most the effect is severe pain for about 30 minutes, however, for those allergic to the sting of a “bluebottle” the effect is more serious and relief from the pain must be sought immediately otherwise resuscitation may be necessary. Relief

from the pain can be achieved by dousing the sting area with alcohol, preferably methylated spirits, or by applying a local anaesthetic (eg. xylocaine jelly) or in extreme cases by an antihistamine injection, administered by a hospital, or advanced medical unit.

I think that the best way to understand the possible severity of the various dangerous marine life is to examine some case studies made by four of the Inspectors.

1. At Bilgola Beach a 17 year old female had a "bluebottle" tentacle wrapped twice around her neck. Lifeguards said she showed only moderate discomfort when they removed the threads. Pain was not extreme, however they kept her under observation after treating her as previously outlined. Five to ten minutes after the threads had been removed the girl showed signs of breathing trouble. An ambulance was called, the girl's condition deteriorated - outward signs were gasping, mild hysteria, and rapid pulse. Her neck began to swell, and she complained of a chocking sensation. Methylated spirits, xylocaine and oxygen therapy had all failed to relieve the choking sensation. Her breathing became erratic, time between gasps lengthened and assisted breathing by the Inspector was necessary. Approximately 25 minutes after the sting, breathing ceased altogether and EAR was commenced. After four breaths her breathing resumed, she was placed on oxygen therapy and transported to hospital where she was injected with antihistamine and her condition stabilised.

2. At Avalon Beach a 25 year old male was stung by a "sea wasp" while skin diving. Initially the Inspector diagnosed the sting as a blue bottle, applied methylated spirits, xylocaine jelly and as the man was experiencing breathing problems, administered oxygen therapy. The symptoms were severe local pain to chest and arms, shallow breaths, and fast weak pulse. The man's condition improved and he was transported to hospital for observation. The sea wasp was recovered the next day and identified by Marineland Staff as Carukia Barnesi, a close relative of the Sea Wasp.

3. At Long Reef Beach a 30 year old male was punctured in the lower leg by a stingray. He experienced severe pain radiating up leg to groin area, nausea, stomach cramps, shallow breathing and shock. Oxygen therapy was administered and treatment for shock improved his condition and he was transported to hospital for treatment.

4. At Palm Beach a 13 year old female was suspected of being bitten by a blue ringed octopus. She had been swimming in a rock pool and had felt an irritation in her hair. She brushed the "thing" away and felt a sharp pain to the side of her neck. The Inspector saw two small puncture marks in her neck. The girl complained of dizziness and felt nauseated. She was treated for shock and the punctured area was washed with cool water. The girl was transported to hospital. Later the pool was drained and a catfish was found.

Generally speaking most cases of marine stinging in Sydney waters will result in discomfort for a half hour period and that is all. However, from the cases outlined I think it is obvious that all sting victims should be observed for that period of time as a safety precaution. Finally it has been observed by the Inspectors that as the "bluebottle" tentacle or thread actually cuts into the skin pores, washing by salt or sea water can aggravate the sensation of sting.

EDITOR: CSIRO scientists have suggested that many young sea creatures, such as "Bluebottles" (Portuguese Men-of-War) and jellyfish, spent their first year of life in the clam centre of a giant eddy situated off the township of Ulladulla in New South Wales. This is a horizontal wheel of water about 240 km across, with a two or three knot flow at its outer edge. Some of the creatures could ride close to the shore at the edge of this eddy or pick up on-shore currents of winds. The bluebottles have a "said" on their float set at about 45 degrees, either to the left or right of the wind. This ensures that about half of any group will escape being blown ashore by any given direction of on-shore wind.

The following selected extracts from local newspaper reports will indicate the problems that can arise when large members of these stingers invade the beaches of the Sydney area. Other areas of the coast can be similarly affected.

"More than 800 surfers were treated for bluebottle stings in the Manly-Warringah area yesterday. One victim, a teenage girl, was treated at a hospital after suffering a particularly severe reaction to the stings."
Manly Daily - 3 January 1976

"More than 200 people were treated for bluebottle stings on the Manly-Warringah beaches during the weekend. Some were in a lot of pain, and one young person was taken to hospital."
Manly Daily - 17 January 1978

"At Bondi a man with stings over his eyes and mouth, and another suffering respiratory distress, were rushed to hospital."
The Australian - 27 February 1978

"More than 1000 swimmers have been stung in a massive invasion by bluebottles of the Manly-Warringah beaches. At one hospital 40 of the 176 people seeking treatment had serious stings. At South Steyne eight gallons of methylated spirits were used to treat victims, and four times the normal amount of oxygen. Many people went surfing despite warnings about the bluebottles, and many competitors in a junior surf championship had to be helped ashore suffering from stings. The Wales rescue helicopter and ambulance was busy taking serious victims to hospital."
Manly Daily - 13 February 1979

"Two swimmers were taken to hospital after being stung at Long Reef. One had to be rescued from the surf and the other collapsed on the beach. They needed oxygen, had trouble breathing, and were in agony."
Manly Daily - 21 February 1979

PAINFUL ENCOUNTERS

Charles Brown MD

REPRINTED BY KIND PERMISSION FROM NAUI NEWS NOVEMBER 1979.

The editor asked me to write something about resort diving for the winter issue. This can't wait till December. Some places can be dangerous. Don't go till you've read this.

I went to Hawaii. A more laid back tropical paradise you couldn't ask. But that's topside. Underwater, the enemy lurks. Steve Kaiser of Gold Coast Divers had ferried us to a great spot off the old Kona airport. It was all cliffs, canyons, and caves. I peered into a darkish cavern (before entering a cave, it's wise to make sure there are no large occupants with big teeth). I braced a forearm upon the edge of the entrance, against the gentle surge. Suddenly I was five feet away, the forearm on fire. It had taken a barrage of hypodermic shots, and I'd flexed liked a spooked lobster.

Now you can't curse worth a damn underwater - the sounds come out all garbled, and there is no audience to appreciate them anyway. So lacking a gratifying alternative I opted for rational behaviour, and forced myself back to the scene of the crime. A lion fish swam nonchalantly away.

I surfaced and took inventory. The forearm showed six punctures a half to three quarters of an inch apart. Each was hurting and swelling. I had to get to shore, but we couldn't desert the other divers. Probably sensing that some foul event would threaten their down time, they's scattered in all directions and couldn't be found. Every minute the swelling increased, and so did the pain. It had two components: a severe localized burning, and an intense ache extending from wrist to elbow.

Finally the rest of the divers were out of air, and we ran for the Kailua pier. Steve radioed ahead for a car, and within twenty minutes I was in my hotel room. No hospital for this problem. I didn't want to waste time checking in and then risk whether the duty doc would know what to do. As a long-time faithful reader of this column, I knew exactly what to do. I ran the bathroom sink full of the hottest water I could stand, and thrust my fuming forearm into it. That might sound like fighting fire with fire, but it works because the venom is heat labile. In minutes the worst was over, and in half an hour the symptoms were nearly gone and I quit.

The next few days I was one cautious diver. Not afraid - just cautious. I knew that sea creatures rarely attack, but rather defend. Unless you're provoking them, it's only the ones you don't see that are dangerous. So just don't go sticking your body parts where you cannot see.

We went night diving to play with the manta rays. They're attracted by light, and the Kona Surf Hotel, bless their promotional adviser, aims powerful spotlights into the water so guests can gawk at the beautiful beasts and crazy divers. A ray comes at you, great maw agape, as though bent upon swallowing you whole.

At the last moment he slowly peels off, almost sandpapering your belly skin with his. It's a panic situation for the uninitiated, but we know they're filter feeders and can't digest divers. They approach not to dine but out of idle curiosity. If you're nimble enough, you can grab and hold and catch a ride.

Perils you think of are no problem its the ones you forget. It was another night, and the fickle rays had not shown. Playing a small flashlight idly over the rocks, I spied a shiny golf ball in a crevice. I reached for it, and at the very last moment froze. I didn't knew why. Something just didn't seem right. I moved the beam a bit and saw it - two malevolent eyes protruding from the rock. It was a huge stone fish, camouflaged to look like rock. Those babies pack a wallop that make lion fish seem tame. There have been fatalities. I was lucky that time, and the scare was a good thing. It drove home a big lesson: *the practice of safety is constant vigilance.*

The next day's diving was gay and carefree. The sea is harmless if you're hip and alert, so enjoy. We cruised sunlit grottoes where lion fish abounded. They were really something to watch with brilliant orange colour and filamentous fins undulating - so dangerous to the dumb and harmless to us. To hold position I reached for a staunch looking coral head, not knowing it was broken and just lying there. As it fell away I instinctively grabbed, and caught a fingerful of sea urchin spines it was hiding.

The long-spined diadema urchin is not deadly, but it's no fun either. The spine tips are brittle as well as sharp, and break off after penetrating the skin. Tweezers don't help - what they grasp just crumbles away. The finger is soon swollen and tender. Those most experienced in dealing with sea urchin wounds the south sea islanders, use a dual therapeutic approach. First they pulverize the spine material, and then they pee on it. Pulverizing is accomplished by repeated pounding with some hard object. As in western medicine, the healer's craft is partly science and partly art. The art consists in knowing when to stop pounding before you pulverise the finger along with the spines. It's unclear whether the benefit of the urine lies in dissolving calcific material or neutralizing toxin, or is psychosomatic or even imaginary. If you mistrust native methods, you can always have a surgeon dig out the spines, or ignore them, and some day they'll go away.

I've chronicled my painful encounters in paradise so readers would be warned. However, in honesty I must admit that not everyone fares so badly. In fact, the other seventeen million people who dived Kona that week had no problems at all. But don't let that lull you into complacency. Remember - constant vigilance, Or next time you may be the one in seventeen million to get zapped!