DISCUSSION PAPER: SHOULD EMERGENCY ASCENT PRACTICE BE MANDATORY?

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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.

6. James RE. Extra Alveolar Air resulting from Submarine Escape. *Naval Submarine Medical Centre Report No 550*. 1968.
7. Davis J. At SPUMS Scientific Conference, 1979. *SPUMS Journal*. 1979 (3) Oct.-Dec: 5-10
8. Jones D. Discussion of a case of Pulmonary Barotrauma. *SPUMS Journal*. 1979 (2) April-Sept: 22-25.
9. Egstrom G. At Downunder 77 Conference. Brisbane, 1977 (unpublished) .

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.

REFERENCES

1. Shilling, CW. Personal communication.
2. *Report of the BS-AC Diving Incidents Panel*. 1979.
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).
5. Ingvar et al. Cerebral Air Embolism during training of submarine personnel in Free Ascent. *Aerospace Medicine*. 1973; 44 (6): 628-635.

ADDITIONAL BIBLIOGRAPHY

Anon. "The ambulance in the valley". *SPUMS Journal*. 1978 (3) July-Dec: 18.

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.