ORIGINAL PAPERS

DROWNING SYNDROMES WITH SCUBA

Carl Edmonds, Douglas Walker and Briony Scott

Abstract

Because of the lack of detail available on the aspiration syndromes associated with scuba diving, two surveys were conducted and compared.

The first survey involved 100 scuba deaths attributable to drowning in the Australian dive fatality series (Project Stickybeak). The second survey involved a questionnaire sent out to divers on the internet who had aspirated and "nearly drowned". There were 48 questionnaires suitable for coding.

The conclusions from the two surveys, and comparisons between them, reveal; the importance of personal diving practice including both medical and physical fitness, the value of experience in undertaking diving operations, faulty equipment and misuse of equipment, the effects of hazardous environments, the value of neutral buoyancy being maintained during the dive and not being dependent upon the buoyancy compensator, as far as possible.

Other factors which increased the likelihood of problems developing and inducing an unsuccessful outcome included; an inadequate air supply, the failure to employ correct buddy diving practices, the failure to become positively buoyant after the start of a diving incident, possible inadequate buddy communication and inappropriate or delayed rescue and resuscitation.

Key Words

Accidents, deaths, drowning, incidents, near drowning, salt water aspiration

Background

A normally functioning human, with adequate equipment in a congenial ocean environment, is protected from drowning as he carries his own personal life support with him, his own air supply. Drowning would only happen when there is; diver error, failure of the equipment to supply air or hazardous environmental influences.

Nevertheless, the commonest ultimate cause of death in recreational scuba divers is drowning. Factual information that clarifies the causes and management of drowning, could be of value in preventing further fatalities.

Previous surveys illustrated the importance of drowning as the ultimate cause in 74-82% of recreational scuba diving fatalities.[1-5] It contrasted with the rarity of the more conventionally accepted diving diseases, decompression sickness and gas contamination, which each accounted for less than 1% of the deaths.

Those surveys also demonstrated the demographic similarity of the USA and Australia recreational diving deaths. This observation is understandable as they have a similar socio-economic standing, are controlled by the same diver instructor organisations and use the same diving equipment.

Of note, in the more detailed surveys, was the high frequency of multiple contributing factors to each death.[3-5] The diagnosis of drowning tended to obscure those preceding factors. The drowning sequelae and drowning pathology were due to the environment in which the accident occurred, not the initiating or primary cause of death.

For example, loss of consciousness when engaging in terrestrial activities is unlikely to cause death. Under water death often follows unconsciousness.

The three major manifestations of inhalation of water in the scuba diving are:

1 Aspiration syndromes (causing symptoms and signs)
2 Near drowning (producing unconsciousness)
3 Drowning (causing death).

The aspiration of sea water causing clinical features in scuba divers, who retain consciousness, has been dealt with in another paper.[6] Sometimes aspiration progresses to the other manifestations of near drowning and drowning.[3,6]

Specific attention to both the scuba drowning deaths and the "nearly drowned" have been poorly documented in the literature. Some texts on diving medicine hardly mention it. For this reason the following retrospective analyses were undertaken and compared.

Surveys

DROWNING SURVEY (DEATHS)

The last 100 scuba deaths attributable to drowning in the Australian Dive Fatality Series (Project Stickybeak) were reviewed. The following criteria were required for admission:

Compressed air diving equipment had to be worn by the victim in the water, with the intent of diving;

Exclusion of all military, large commercial or helium diving activities;

At least 3 of the 4 following sources of detailed information;

A Coroner's Inquest of Inquiry (full transcript including witness declarations and cross-examination);

Autopsy findings (anatomy, histology and toxicology in detail);

Official Government (Navy, Water Police etc.) assessment of equipment functioning and in-water trials. This included gas analysis of scuba tank compressed air;

Detailed written accounts of witnesses (buddies, other divers, boatmen or bystanders, rescuers).

All cases with the above criteria and designated as drowning in Project Stickybeak were included. These mainly covered a period over the last decade, although it had to be extended to obtain some data from the preceding decade, to as far back as the early 1980s.

NEAR-DROWNING AND ASPIRATION SURVEY (SURVIVORS)

Diving organisation, both national and international, which had previously promoted themselves as collecting diving accident questionnaires, were approached for assistance.

With one exception, they could give no information or supplied data with insufficient detail to be of any value. PADI (Australia) did supply valuable data on 12 divers, but too late to include in this paper. It will be coded as part of an ongoing study of this condition.

So a new survey was carried out, using various message boards and web sites and organisations on the Internet, during the first three months of 1997. We guaranteed anonymity to the respondents, although the names of the respondents were given in all but one case.

A questionnaire entitled "Have you nearly drowned?" was submitted to Web sites that were designed for divers. To increase compliance the questionnaire was kept to 2 pages, but it was designed to supply most of the information we required. If the diver wished, there was the option of supplying more information.

Forty-eight replies were able to be coded, some others were either not comprehensive enough to include or not pertinent. Only completed questionnaires were used.

Demographics

The average age of the survivor group was slightly older than the fatalities, probably reflecting the fact that survivors, by definition, have added some time to their post-incident life span.

Of the 100 fatalities, 89% were male, 11% female. During this period the female frequency amongst divers varied from 25- 35% depending on the years involved and authority sought. Of the 48 survivors , 52% were male and 48% female.

Compared with the diving population at the time, it appears that males are over represented in the scuba drowning cases, as they are in almost all other forms of drowning.[6] The surprise was that females appeared to be over represented in the "survivor" series. Whether females had more accidents, or whether they only reported them more frequently, could not be deduced. However, it does appear as if the female accidents result in fewer deaths. The gender response on the Internet (survivor) survey also was a surprise. We had presumed, in common with most other marketing groups, that the Internet would be dominated by males.

Personal factors

TRAINING

In the fatalities, 54% had completed scuba training but a high 38% had no known formal qualification. This group were approximately equally divided between:

a those in whom the documentation was inadequate;

b those without training, but who were experimenting with scuba on their own or with their friends;

c those who were engaged in introductory dives, brief resort courses or "dive experiences" with a recognised commercial organisation.

Of the survivors 81% had completed training and only 4% had no formal qualification. A surprising number in both groups were under formal training at the time, 8% of the fatalities and 15% of the survivors.

EXPERIENCE

This did not entirely correlate with training. In both the fatality and survivor series, the divers were equally represented amongst inexperienced (< 5 dives), novice divers (usually 5-20 dives) and experienced divers, one third each.

Of the fatalities, over one half were experiencing diving situations to which they had not been previously exposed, and only one third had previous experience of the conditions in which they died. The others were unable to be assessed.

The buddy or dive leader appeared to be considerably more experienced than the diver in most cases, possibly explaining why the diver died and the buddy survived.

The survivor questionnaires were not appropriate for us to compare the relative experience of the divers to undertake the eventful dive.

TABLE 1

Experience	Fatalities	Survivors
Nil or slight	37%	31%
Novice	30%	35%
Experienced	27%	29%
Very experienced	6%	4%
Experienced enough to under take the dive		
No	56%	
Yes	32%	

VICTIM'S BEHAVIOUR

In those fatalities that were observed (to achieve 100 cases we had to extend the survey beyond the last 100, because of the number of "solo" divers) over a third were noted to have either a panic response or rapid/abnormal movements.

Over half the survivors reported these sensations. The increased incidence of panic and rapid or abnormal movements in the surviving group could well be attributed to the fact that this is a reported sensation, whereas the fatality figure represented the observed behaviour. Panic could well have been experienced, but not necessarily observed in the latter group. Over half the fatalities showed no change in their behaviour, with loss of consciousness being the first objective warning in a third. Loss of consciousness was the first manifestation noted in a quarter of the survivors.

Of interest was the absence of panic in many of the cases, during the development of the incident, even though it is a frequent initiator of other diving deaths.[1-3,6] Drowning scuba divers frequently drown quietly, possibly because of the effects of previous aspiration (hypoxia), depth (narcosis) or training ("don't panic", like the "drown proofing" of babies).

Twenty one percent of the fatalities requested assistance, in the form of an air supply. It was difficult to judge the success of this in many instances, as although they were sometimes reported as successful, the subsequent events would indicate otherwise. A request for a supplementary air supply was made by twice as many fatalities as survivors. This may bring into question the value of relying on a buddy responding to such a request. Alternatively, as we will see later, it is more frequent for the buddy to offer an emergency air supply, and this may be appreciated.

Occasionally there was the apocryphal underwater tussle for a single regulator. When the "low on air" (LOA) diver went for an air supply, he more frequently sought the companion's primary regulator than the octopus.

TABLE 2

Victim's behaviour	Fatalities (Observed)	Survivors (Reported)
Panic	21%	27%
Rapid/abnormal movement	16%	31%
Nothing unusual	63%	42%
Loss of consciousness	33%	25%
Air requested	21%	10%

MEDICAL DISORDERS

This is a contentious area, not only regarding the incidence of medical disorders but also their significance. Authors differ in their assessments of this[3,6,7] and none are free of prejudice.

Project Stickybeak is the most comprehensive data base of diving fatalities available. It is compiled by Douglas Walker in Australia and has been running for 25 years. Unfortunately, any medical history obtained from these records is inevitably an underestimate. In one analysis originally based on such data,[3] when an attempt was made to search for and complete the medical history, in less than half of the cases could this be achieved. Even then, it was often not up to date. A complete medical history, or even the routine diving medical history and examination forms, was not usually available

A statistical axiom is that absence of evidence is not evidence of absence. Questioning dead divers is not productive. Survivors, completing questionnaires, probably supply more accurate assessments. To avoid controversy, in this survey no attempt has been made to draw conclusions regarding the correlation between past illnesses and subsequent drowning. Table 3 shows the incidence of some disorders

Environmental factors

WATER CONDITIONS

The adverse influences of water conditions were as expected. Surprisingly over half the drownings occurred in

TABLE 3

Medical disorder	Fatalities*	Survivors
Asthma	10%	19%
Cardiovascular	6%	2%
Drugs	10%	8%
Very unfit	5%	4%
Panic	7%	8%

* History often not questioned

calm water as did 60% of the survivals. In 4% of the deaths calm conditions deteriorated. Moderately rough seas were associated with 25% of deaths and 40% of the survivals. Very rough conditions, hardly ideal diving conditions, were associated with 15% of the deaths. Currents were associated with 46% of the deaths and 31% of the survivals.

Strong tidal currents were more frequent (9%) in the fatality group than in the survivors (0%).

FRESH OR SEA WATER.

Most of the accidents occurred in the ocean without obvious differences between the fatality (93%) and survivor (98%) groups. The extra difficulty of performing rescues in cave diving (2% of the deaths) is obvious.

DEPTH OF INCIDENT

As in previous surveys,[1,3] over half the problems in the fatality cases were observed on the surface, although this was frequently related to the fact that the diver no longer had an adequate air supply to remain under water.

In referring to depth, we are measuring the commencement of the aspiration/drowning incident, not necessarily the original problem. For instance a diver who had been diving excessively deep (related to their experience), had used most of the air supply and then panicked and ascended, might then not show any evidence of aspiration until he reached the surface.

Approximately half the fatalities occurred while on the surface or on the way to the surface. Another 20% occurred in the first 9 m and the rest were distributed as shown in Table 4. This implies that just reaching the surface is not enough. Successful rescue requires the victim to remain there.

The survivors, probably because of the ability to supply a more detailed and specific history, indicated a greater incident depth. They probably more accurately represented the depth at which the incident developed, as opposed to the depth at which the incident was noted by others. Nevertheless, almost two thirds occurred in the top 10 m.

In the fatality and the survivor groups, the dive was the deepest of their diving career in 26% and 33% respectively. In almost half the "inexperienced" and "novice" divers the depth was beyond any previous dive, suggesting that these groups are especially susceptible to the various problems associated with depth (air consumption, poor visibility, narcosis, panic and logistic difficulty with rescue). This demonstrates that it is not so much the environment that is the problem, but the diver's experience of that environment. The danger of "diving deeper" without extra prudence and supervision is apparent. Any dive deeper than that previously experienced should be classified and treated as a "deep dive", irrespective of the actual depth.

TABLE 4

DEPTH OF INCIDENT

Incident depth	Fatalities	Survivors
Surface	51%	15%
During ascent	-	17%
1- 9 m	20%	33%
10-18 m	10%	15%
19-30 m	10%	13%
31-45 m	3%	6%
46-60 m	6%	2%
Diver's deepest dive	26%	33%

VISIBILITY

Visibility was usually acceptable, but seemed to be more frequently adverse in the fatalities (poor 26%, deteriorated 4% and night 5%) compared with the survivors (poor 18%).

ADVERSE ENVIRONMENTS

The cases, in general, demonstrated the adverse effects of various environments, especially with tidal currents (deaths 55%, survivals 31%), white (rough) water (deaths 44%, survivals 41%), poor visibility (deaths 26%, survivals 18%), cold (deaths 14%, survivals 12%) and deeper diving than previously experienced (deaths 26%, survivals 33%). There was not a great deal of difference between the two groups, except in the higher incidence of strong tidal currents, night diving and cave diving in the fatalities. The numbers, however, were small.

If such observations are valid, then they may reflect either the effect on the victim or the problems with rescue produced by such environments.

Equipment

In most fatalities the equipment showed no structural abnormality. Only in 20% did significant or serious *faults* contribute to the fatality. This corresponded with the reported incidence by the survivors (18%). Minor faults observed probably would not have contributed significantly to the deaths (11%). Equipment faults were most frequently found with buoyancy compensators and regulators (both first and second stages).

Equipment *misuse* was more frequent but more difficult to ascertain in the fatality series and depends on one's definition (deaths 43%, survivals 38%).

Our definition of equipment misuse included the use of excessive weights (deaths 25%, survivals 27%) or the failure to carry equipment that could have been instrumental in survival such as buoyancy compensator, contents gauge, snorkel, etc. (deaths 12%, survivals 8%). Difficulties in using buoyancy compensators were frequent.

The incidence of equipment misuse would be much higher if one included a compromised air supply. Of equal interest was the failure to utilise equipment to ensure buoyancy following the incident. These are dealt with under diving technique.

Diving technique

Various diving techniques seemed to contribute to the drowning incidents, or influenced rescue and survival. They include a compromised air supply, buoyancy factors, buddy rescue and resuscitation attempts.

AIR SUPPLY

In 60% of the fatalities either an out-of-air (OOA 49%) or low-on-air (LOA 11%) situation had developed. There was insufficient air in the tank for either continuing the dive or returning to safety underwater.

In the survivors there were fewer incidents of compromised air supply (OOA 27%, LOA 8%), but it was still very frequent. The survivors tended to be more likely to have enough air in their tanks (more than 1/4 contents) to cope with an emergency (deaths 40%, survivals 65%). The difference is more if the cut off point is taken as half a tank (deaths 29%, survivals 45%).

In both groups failure to use the available contents gauge properly was common. This could sometimes be attributed to the conditions placing other stresses on the diver (depth, anxiety, tidal current, deepest dive ever, etc.). In many more cases there appeared to be a voluntary decision to dive until the tank was near reserve or "ran out".

One surprising feature was the failure in both groups (deaths 8%, survivals 13%) to turn on the tap of the scuba tank. Even though there was plenty of air in the tank it was unavailable, other than to sometimes allow a rapid descent to 10 m or so. Only then was the diver aware that further air was not available. In none of these cases had the diver breathed from the regulator before getting in the water nor had there been a buddy check of equipment nor an equipment check before descent.

In a smaller number of cases the diver had failed to turn the tap back on adequately, after checking the tank pressure and turning it off. The result was a partial restriction of the air supply, which became obvious only later in the dive or at depth.

BUOYANCY FACTORS

For survivors buoyancy was frequently a vital factor in reaching the surface and in remaining there as an unconscious diver. This gave the chance of being found, rescued and resuscitated in time. The 3 major influences on buoyancy are the buoyancy compensator (BC), weights and the companion (buddy) diver practice.

Buoyancy compensators

Failure to inflate the buoyancy compensator was common in both groups (deaths 52%, survivals 32%). In a few cases the buoyancy compensator failed to inflate for mechanical reasons (deaths 5%, survivals 8%). In 12% of the deaths the buoyancy compensator had been inflated before the incident.

In the survivor group the BC was inflated by the victim (deaths 15%, survivals 35%) or rescuer (deaths 16%, survivals 25%) in twice as many cases as in the fatality group (deaths 31%, survivals 60%). This figure is even more relevant when the delay in producing buoyancy in the fatality group is considered (see later).

Weights

In the vast majority of cases in both groups the victim did not drop the weight belt (deaths 86%, survivals 74%). Only about a fifth of both groups actually dropped their weight belts (deaths 13%, survivals 21%). Some unfortunates dropped their belts but became entangled (deaths 3%, survivals 2%). About the same number were not wearing weight belts (deaths 1%, survivals 6%).

Although in 30% of the fatality cases the weights were ditched, in practice this was not as valuable as it sounds. In most of the instances in which the rescuer ditched the weights (20), the victim was probably no longer salvageable, because of the delay (see later).

The survivor group not only ditched the weights more frequently, but more often it was done by the victims themselves, and when it was done by the rescuer, it was usually performed early in the incident.

Buoyancy action by victim

It appears that the fatality and survivor groups differed in that the latter tended to perform an action, either inflating the BC (deaths 15%, survivals 35%) or successfully dropping the weight belt (deaths 10%, survivals 19%), which resulted in them achieving positive buoyancy during and following the incident.

An interesting observation was that when the victim and buddy were both in difficulty, usually because of a LOA/OOA situation, irrespective of whose problem developed first, the overweighted diver tended to be the one that died and the buoyant diver the one that survived. The ratio of the two were 6 to 1, in the 14 instances.

All this gives support to the current emphasis by Instructor agencies on buoyancy training, although one could argue for its inclusion in the introductory courses more than the advanced courses. However, there is obviously a need to emphasise that weight belts should be dropped when in trouble.

COMPANION DIVER PRACTICE, RESCUE AND RESUSCITATION

In most cases of significant aspiration of water, rescue depends on rapid action being undertaken by either the victim or the companion (buddy) diver. Once a diver gets into difficulty and is unable to carry out safety actions by himself, he is heavily reliant upon his buddy or dive leader.

The fatality and survivor populations were so different in this respect, that we had to separate them.

FATALITIES

Buddy experience

In the fatality group only 41% of the victims had an experienced buddy. Twenty one percent were diving alone and 32% were diving with a novice, or less experienced, diver. In the majority of cases the buddy's experience hardly mattered as only in 8% of the deaths was a buddy present throughout the incident.

Buddy diver/group practice

In 21% of the fatalities, the dive was a deliberate solo one. Voluntary separation had occurred in 50% of the deaths before the victim died. In 38% the diver had separated from his buddy, and in another 12% from the group, before the incident. Separation was initiated in 31% because the victim could not continue the dive (usually due to a LOA situation). The victim then attempted to return to the surface alone, a solo dive, so that 52% of the fatalities were alone when they died.

The diver was separated from his buddy or the group during the actual incident, and often by the incident, in 21% of cases. But, in almost half of these cases the separation was because the diver was behind his buddy or the group. The others occurred during the "rescue".

The diving practice of voluntarily separation in 71% of cases made early rescue and resuscitation improbable. Another 9% were swimming behind their companion/s and the victim was not visible to the "buddy" at the time of the incident. In fact, 80% of the victims did not have a genuine buddy, by virtue of their elected diving practice.

In less than one in ten deaths (8%) was there a continued contact with the buddy or group during and following the incident.

The fatalities seemed to have flagrantly disregarded the "buddy" system, as did their companions, the organisation which conducted the dive, or the "dive leader". Group diving conferred little value because the "leader" often had insufficient contact with individual divers to be classified as a buddy and the responsibility of others was not clear, especially towards the last of the "followers".

Rescuer action

As the buddy system was essentially not used in the fatality group, the commonest response to the accident by the other divers was that no attempt was made to rescue the victim (31%). The second commonest response was that an attempt was made, but failed (24%). This is understandable, when one appreciates that no one knew where the victim actually was. A smaller number of rescuers actually found the victim and attempted a rescue, with some initial response by the victim (17%).

In a quarter of the cases there was no search for the victim until after the planned dive had been completed and it was realised that the victim had not returned. In these cases there was a search for the body, which failed in most cases. In a number of the cases it was not the original buddy or group diver who undertook the attempted rescue or search. Sometimes it was other divers who were coincidentally in the same area. In other instances coincidental observers, from shore or boat, were aware of the victim's distress and undertook the rescue attempt.

Body search

There was no need for a body search in 26% of the deaths. A formal search for the diver's body, undertaken separately and usually well after the dive, was successful in a third of the cases, with another third successful during future attempts. In a very small number (7%) the body was found coincidentally and in only 3% was it never found.

Resuscitation

Resuscitation was not a feasible option for most of these cases, who were obviously dead or showed no response to the rescuers attempts in 9 out of 10 cases. This is explained by the excessive delay in the rescue in most cases. There was an initial response to resuscitation in 7% and ineffectual resuscitation was applied to 2%.

Delay in rescue

In only 20% was the diver rescued within 5 minutes of the probable incident time, giving a real chance of successful resuscitation. In another 12% the diver was recovered within 5-15 minutes. Theoretically there was a slight chance of recovery for these divers, had the rescue facilities been ideal and had fortune smiled brightly. Recovery of the body took 16-60 minutes for 19%, hours for 36%, days for 5%, weeks for 5% and 3% of the bodies were never found.

Autopsy

In 10% either the body was not available or an adequate autopsy was not performed. In the remaining 90% the autopsies were either routine (72%) or conducted specifically by a diving pathologist (18%).

SURVIVORS

In the surviving group most were rescued by their companion. Some form of artificial respiration or CPR was required in 29% of the cases. Oxygen was available and used, usually in a free-flow system, in 52% of cases.

Rescuers behaviour

No specific data is available on the buddy divers assisting the survivors, other than the subjective assessment as to whether the survivor believed the buddy to be of much value. The buddy was immediately available to the survivor in 71%, was considered to be of assistance in 58%, supplied an independent air source in 15%, inflated the BC in 25%, ditched the weight belt in 25% and attempted buddy breathing in 4%. In 52% the diver surfaced under the buddy's control.

The attitude toward buddy diving practice with the survival group appeared to be very different to those in the fatality group. To successfully rescue an incapacitated diver one must know where he is and reach him quickly. This implies some buddy responsibility. The buddy divers in this series seemed to be of considerable value once they reached the victim, implying good training in this aspect of diver safety. The high figure for oxygen utilisation must represent a more sophisticated and organised diving activity, which may also be related to a more conscientious attention to responsible buddy behaviour.

Of recent years there has been a promotion of solo diving and reliance upon oneself rather than on a buddy.

Denying or repudiating the hard-learnt lessons of the past is fashionable and innovative, implying a diving expertise and an avant garde approach, as well as ensuring an audience. In diving medicine it is also easier than acquiring practical experience or doing the hard data collection. In this instance, as in others, these "experts" may well be misleading both their contemporaries and the diving trainees.

Conclusions

There are many lessons to relearn from this survey, as well as from the diving medical experience of the past, to reduce the likelihood of drowning with scuba (Table 5). Drowning prevention measures fall into three groups, Before and during the dive (1-7), When a problem develops (8 and 9) and survival requirements (10). They can be summarised as follows.

1 Personal factors

Ensure both medical and physical fitness, so that there is no increased likelihood of physical impairment or loss of consciousness or difficulty in handling unexpected environmental stresses.

2 Experience

Ensure adequate experience of the likely dive conditions (dive under the supervision of a more experience diver, when extending your dive profile).

TABLE 5

DROWNING PREVENTION

Before and during dive	
1	Personal fitness
2	Experience adequate for the dive
3	Equipment checked and working properly
4	Environment safe for experience level
5	Buoyancy (dive neutral)
6	Air supply adequate, turned on and monitored
7	Buddy diving done properly
When a problem develops	
8	**Increase buoyancy (become positive)**
	Unbuckle weights and inflate BC
9	Inform buddy, if feasible
Survival depends on	
10	Rescue, first aid and medivac
	All need to be planned before the dive

3 Equipment

Although faults with diving equipment are inevitable, they are a less frequent contributor to drowning than misuse of equipment. The latter includes the practice of overweighting the diver and over reliance upon the buoyancy compensator. Failure to possess appropriate equipment is a danger, but not as much as the failure to use the equipment safely. Permitting a compromised air supply is dangerous.

4 Environment

Hazardous diving conditions should be avoided. Use extreme caution with tidal currents, rough water, poor visibility, enclosed areas and excessive depths.

5 Neutral buoyancy

Ensure neutral buoyancy while diving. This implies not being overweighted and so not being too dependent on the buoyancy compensator.

6 Air supply

An inadequate supply of air for unexpected demands and emergencies may convert a problematical situation into a dangerous one. It also forces the diver to experience surface situations that are worrying and conducive to anxiety, fatigue, unpleasant decision making and salt water aspiration.

Equipment failure is not as common a cause of LOA/OOA as failure to use the contents gauge and/or a decision to breath the tank down to near reserve pressure.

7 Buddy diving.

Use traditional buddy diving practice, 2 divers swimming together. Solo diving, for the whole or part of the dive, is much more likely to result in an unsatisfactory outcome in the event of diving problems. It is the divers who are committed to the traditional buddy diving practices who are likely to survive the more serious of the drowning syndromes.

8 Become positively buoyant.

Positive buoyancy is usually required if problems develop. This can be done by dropping weights and inflating the BC.

Failure to remove the weight belt during a diving incident continues to be the major omission and must reflect on training standards. In most situations, unbuckling and then ditching (if necessary) the weight belt is the most reliable course of action once a problem becomes evident. Buoyancy compensators cause problems in some emergency situations and, not infrequently, will fail to provide the buoyancy required. They are of great value in many cases, but are not to be relied on.

9 Buddy communication

If feasible, inform the buddy prior to ascent. If correct buddy diving practice is being carried out, he will automatically accompany the injured or vulnerable diver.

10 Rescue

Rescue, first aid and medivac need to be planned before the dive. Employ the rescue, water retrievals, first aid facilities (including oxygen) that have been discussed before the dive. Know how to contact the medivac systems and have the necessary equipment before the dive.

Acknowledgments

Douglas Walker was gracious enough to supply the complete documents of all the scuba drowning cases, for perusal and coding. Briony Scott arranged the computer analysis and Internet access, with subsequent documentation. Carl Edmonds assessed the material, coded it and drew the conclusions. Any errors in assessment or conclusions are purely his responsibility.

References

1 McAniff JJ. *United States underwater diving fatality statistics 1970-79.* Washington DC: US Department of Commerce, NOAA, Undersea Research Program, 1981
2 McAniff JJ. *United States underwater diving fatality statistics 1986-87.* Report number URI-SSR-89-20. University of Rhode Island, National Underwater Accident Data Centre, 1988
3 Edmonds C and Walker D. Scuba diving fatalities in Australia and New Zealand: 1. The human factor. *SPUMS J* 1989; 19 (3): 94-104
4 Edmonds C and Walker D. Scuba diving fatalities in Australia and New Zealand: 2. The Environmental

Factor. *SPUMS J* 1990; 20 (1): 2-4
5 Edmonds C and Walker D. Scuba diving fatalities in Australia and New Zealand: 3. The Equipment Factor. *SPUMS J* 1991; 21 (1): 2-4
6 Edmonds C, Lowry C and Pennefather J. *Diving and Subaquatic Medicine, 3rd Edition.* Oxford: Butterworth/Heinemann, 1989
7 Walker D. Divers with asthma: an investigation is required. *SPUMS J* 1995; 25 (4); 259
8 Edmonds C. Drowning syndromes: the mechanism. *SPUMS J* In press.

Dr Carl Edmonds, FRANZCP, FRACP, Dip DHM, who was the one of the founders and the first President of SPUMS, is Director of the Diving Medical Centre, 66 Pacific Highway, St Leonards, New South Wales 2065, Australia. Phone +61-(02)-9437-6681. Fax +61-(02)-9906-3559.

Dr D G Walker is a foundation member of SPUMS. He has been gathering statistics about diving accidents and deaths since the early 1970s. He is the author of the series of Provisional Reports on Australian Diving-related Deaths which have been published in the Journal covering 1972 to 1993. His address is PO. Box 120, Narrabeen, New South Wales 2101, Australia. Fax + 61-02-9970-6004.

Briony Scott, BSc.Agr, M.Ed, resides in Myrtle Street, Balgowlah, NSW

This paper served as the basis for a presentation to the Undersea and Hyperbaric Medical Society (UHMS) Workshop on Drowning and Near Drowning, June 1997, at Cancun, Mexico.

*Its companion paper (*Drowning syndromes: the mechanism*) will appear in the March 1998 issue of the SPUMS Journal.*

THE WORLD AS IT IS

AUSTRALIA'S UNDERWATER LINE DANCING RECORD ATTEMPT

Peter Fields

Following the spectacular growth and success of the Historical Diving Society in the USA, an outfit which has attracted diving luminaries such as Hans and Lotte Hass, Jean-Michel Cousteau, E R Cross, Bev Morgan, Phil Nuytten, Dr Sylvia Earle and many other celebrities too numerous to mention, our own representative Bob Ramsay, the expatriate Scot from Adelaide, set up a branch in 1996 in Australia. Since then the Diving Historical Society Australia SE Asia has blossomed and is attracting people from all parts. Folk with a love of diving and its history, collectors and restorers of old equipment and aficionados of standard dress (hard hat) diving.

After a succession of social get-togethers in the region Bob was looking for ideas for something a bit more grand. Over a few beers one Adelaide evening Bob was musing on what to do with, say, 3 or 4 helmet divers in a pool. John Riley, in a flash of alcoholinspired mischief, suggested a line dancing competition. Bob was entranced and passed on the idea to Melbourne's John Allen. So was born the Word Record Attempt for Underwater Line Dancing.

John Allen ran with the idea and, using his brilliant organising skills, created not only a superb record attempt but a whole weekend of entertainment and recreation for standard dress lovers, society members and their friends from all over Australia.

On a fine spring Saturday in October nine men and one woman in traditional helmet diving dress, plus all the myriad paraphernalia which accompanies this activity, lined up at the Harold Hold Swim Centre in Glen Iris (in suburban Melbourne), Victoria, ready to create a record.

John Allen had planned the event down to the last detail; pallets of 240 cu ft cylinders, delivered by BOC Gases, were on hand, media fact sheets had been handed out to print and electronic media, a detailed scheme of underwater arrangements was set out on a white board, a cook tent and canteen set up to provide breakfast and lunch for the participants and a local bootscootin' club alerted to be on hand to coach the tyro standard-dress line dancers.

In addition, topside and underwater supervisors were briefed and ready to direct and assist the divers, easy access to the 5 metre deep pool was provided via builders' ladders and a range of trophies and certificates awaited the successful conclusion of the dive. Awards were to be given for: Best Presented Equipment, Best Dressed Dive Crew and, most coveted of all, Best Underwater Line Dancer.

To further illustrate the depth and detail of John's organising skills, extra dive crew hands were on duty to assist, spare Desco cuffs were on stand-by in case of blow-out and Melbourne dive historian Jeff Maynard and your correspondent were detailed to handle media arrangements and enquiries.