US UNDERWATER DIVING FATALITY STATISTICS, 1970-80

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This is the most recent of the series of reports prepared by John McAniff, Director of the National Underwater Accident Data Centre, University of Rhode Island. Two up-dates are reportedly due for publication shortly.

The number of identified diving-related deaths has shown a tendency to remain constant for the last four years reviewed, which represents a reduction in the incidence rate because of the increased number of divers "at risk". In America, as elsewhere, problems are experienced in obtaining adequate information but "late cases" are added in as discovered, so numbers quoted in all the tables are as accurate as the most recently available information allows.

TABLE 1

Annual Diving-related Fatalities by type and year

	1970	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
SCUBA, sport	110	112	119	125	144	131	147	102	116	130	109
Snorkel, sport	19	17	16	22	27	17	14	19	16	12	20
Commercial	9	4	4	4	16	13	14	23	12	8	20
TOTAL	138	133	139	151	187	161	175	144	144	150	149

The imprecision of information, a bane to anyone seeking to extract more from a fatality report than the compilers thought necessary to include, is highlighted in the discussion on "Personal Floatation Devices". As has been noted in other reports, there are many types of such devices and without the victim's equipment being described in exact terms it is frequently impossible to be certain what methods of inflation were available to the wearer. The omission of any autopsy in 27% of the 1980 cases seems rather high, and the suggestion by the author that such an examination would have resulted in 20 of the 60 cases of "asphyxia or drowning" being diagnosed as "lung over-pressure" may be thought over optimistic. Even had the medical examiners followed Dr Kindwall's protocol it is possible that they would have required the presence of gross lung damage before admitting the diagnosis of Cerebral Arterial Gas Embolism (CAGE) unless they found air in the ventricles. Few pathologists take account of the circumstances of diving when giving their opinions, otherwise such terms as "asphyxia" would not be presented without explanation of the supposed mechanism of causation. As it is accepted clinically that CAGE is diagnosed and treated on the basis of the history in the common absence of evidence of lung damage, so too should an informed pathologist make the diagnosis on the basis of probability. Perhaps the pathologist should talk to some live divers before starting the autopsy!

It should come as no surprise that the inexperienced figure so prominently in the deaths. This group is composed of those making their first-ever dive or on a very early sea dive. There is an important comment made about the importance of the instructor never withdrawing attention from any pupil even when the exercise is completed and at the surface. The potential for irretrievable disaster is ever present. Verily the Sword of Damocles hangs over every instructor while in the water.

No report can be expected to please everybody, there being limitations of time, money and available information to circumscribe the author's efforts. This is, as clearly stated in its title, a statistical report and has the limitations of such an approach in dealing with circumstances where almost invariably there are a number of factors operating to influence the course of events. The Tables deal in single factors, events in multiples. Many persons dive without a buoyancy aid, separate from their companion(s), or are grossly ignorant, yet survive. It is a combination of adverse factors which makes survival problematical when something goes wrong. It is for such reasons that brief case reports are so valuable. Unfortunately few are supplied. It is by such reports that diver readers begin to identify with the victim's troubles and (hopefully) learn the principles of safer diving. It is such vignettes as the following which bring home forgotten dangers.

An "experienced diver" was diving from a boat in a mountain lake and made a back-roll entry into the water after attaching a line to his weight belt. It had been his intent to don his fins, left in the boat, after entering the water but in practice he immediately sank to the lake floor, 125-150 feet deep. Pulling on the line produced the belt but not the diver. When recovered he was still retaining the snorkel in his mouth. No Table could adequately teach readers the several lessons of this tragedy, viz: he was greatly overweighted, so presumably not experienced in fresh water diving, and had failed to check his equipment, the tank feed to his buoyancy vest being unattached. Entering the water without fins is never a sensible option when otherwise fully equipped, though had he held his regulator in his mouth on entry he might have survived, albeit with very sore ears. The retention of the snorkel in his mouth suggests the possibility of an imperative reflex respiratory response to sudden immersion in cold water, with inhalation and sudden death. Tables give valuable data, but action replays give impact.

The dedicated work by John McAniff and his colleagues is

of great value to all divers, not merely those in the USA. As is true also of efforts in Australia and New Zealand, the scheme also collects non-fatal Incident Reports. These will be co-ordinated with the DAN records to gradually build up a significant data store. It is hoped that future reports will seek to close one gap in the present tables of information, the depth of the incident. It has been shown in both Australia and New Zealand that many fatalities occur at or near the surface, the water/dive depth not necessarily being a critical factor.

Please support your local Incident Scheme. Something you report could save a life.

TABLE 2

Stated Experience of Scuba Diving Fatalities

	1970	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
Inexperienced	48	47	33	43	54	39	45	37	44	47	52
"Experienced"	52	63	67	46	46	61	55	63	56	63	48
Not Stated	10	2	9	36	44	31	47	2	16	20	9
TOTAL	110	112	119	125	144	131	147	102	116	130	109

HYPOXIA IN OUT-OF-AIR ASCENTS
A PRELIMINARY REPORT

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In December 1977 the Undersea Medical Society (UMS) convened a workshop on Emergency Ascent Training in Bethesda, Maryland, supported by a National Oceanic and Atmospheric Administration (NOAA) grant. At the conclusion of the workshop, it was found that rather than answering many of the questions, the conference had served rather to define those areas requiring further investigation.

It was suggested by one of the participants that critical levels of hypoxia were likely to occur in the course of any emergency ascent arising as a result of an out of air situation and that this hazard might well rank with that of air embolism. Surveys of deaths occurring while scuba diving reveal variable numbers of drownings. The Rhode Island survey (2) shows 70% of scuba deaths due to drowning, our own statistics in Ontario (3) indicate a lower figure of 66%. Detailed examination of these reveals that many drownings are secondary to embolism. Others may have been secondary to this or other difficulty but missed due to improper autopsy technique, or no autopsy, but there remain a number of these deaths which may well be due to hypoxia before the surface is reached. Whatever the cause, failure to reach the surface has been uniformly fatal in our experience. (Table 1)

The majority of the participants were sceptical, but the concept appeared to merit further investigation and this paper is devoted to an initial hypothetical analysis of this problem and a preliminary report of a series of experimental ascents to test the hypothesis.

TABLE I

OUTCOME OF 37 SERIOUS DIVING ACCIDENTS

TOBERMORY 1974 - 1982

	Deaths	Survivors
Failed to surface	12	0
Surfaced	3	22
Totals	15	22

These cases include cerebral air embolism (CAE) and carbon monoxide (CO) poisoning.

PROBLEM ANALYSIS

If we analyse the situation which exists when a diver runs out of air, we can derive his available oxygen (O2), the projected O2 cost of the ascent and then predict the course of his PaO2. Certain conditions must be assumed for this exercise and we have selected the following.

Our diver is an 80 kilo man, reasonably fit with a vital capacity predicted for 184 cm height and 32 years of age, 5.7 litres.(4) We have further assumed that he has a haemoglobin (Hb) of 15.0 gm% and a total blood volume of approximately 6 litres represented by 2042 ml oxygenated blood and the balance mixed venous.(5)

The out of air emergency is assumed to occur while the diver is swimming actively at a level which has produced a steady state and that the lack of air is discovered by the diver, when he attempts to breathe in following a normal expiration. He is assumed to be in standard sport diving dress (wet suit and fins).