whatever happens to you underwater! You are a terrestrial mammal. You have no business going underwater in the first place. If you cannot accept the responsibility, then stay out of the water. If you get bent after a dive on which you have included deep safety stops by my suggested method, then it was your own fault for being stupid enough to listen to decompression advice from an ichthyologist.

Acknowledgment

I would like to thank Eric Maiken for explaining bubble physics to me and for adding some theoretical foundation to my silly ideas.

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WHEN THINGS GO WRONG

Brian Cumming

Key Words

Accidents, deaths, decompression illness, equipment, incidents, safety, trauma.

Most of the 315 UK sports diving incidents that occurred in the 12 months to the end of September 1996 could have involved any one of us. Sure, there were a number of really stupid ones that I hope most people would have avoided, but it is all too easy to adopt a self-righteous attitude towards the mishaps of others. Who, if we are honest, can claim an error-free diving career?

The 1996 incidents represent a 10 per cent reduction on the number recorded in the previous year, which itself was 9 per cent down on 1994. We cannot be sure that this indicates increasing safety, but it is clearly a trend in the right direction.

Data for the BSAC's annual report comes from its own incident reporting scheme, the Coastguard, Royal National Lifeboat Institution, British Hyperbaric Association (BHA), through the Institute of Naval Medicine (INM), newspapers and other independent sources.

We also receive information on overseas incidents but only record and publish those relating to BSAC (British Sub-Aqua Club) members and do not count them in the statistical analyses.

TABLE 1

INCIDENTS BY MAJOR CATEGORY

Boat or surface*	98
Decompression illness*	77
Injury	30
Overseas	29
Ascents	22
Technique	22
Equipment	19
Deaths*	16
Miscellaneous	2
Total	315

These figures were obtained from a coloured bar graph, which did not translate well into black and white, by measurement of the bar heights and the numbers scale height.

* These figures were obtained from the text.

The spread of incidents throughout the year is typical, most incidents occurring in spring/summer, with a big step up at Easter. Of those incidents where the depth is known, most are at the surface, including divers, boating incidents and those occurring out of the water.

TABLE 2

INCIDENTS BY MONTH

Month	Year	Incidents
October	1995	11
November	1995	10
December	1995	6
January	1996	4
February	1996	7
March	1996	11
April	1996	40
May	1996	33
June	1996	42
July	1996	42
August	1996	48
September	1996	22
Total		276

The in-water incidents occurred predominantly in the 21-30 m range. My guess is that this is not an especially dangerous range but simply where most dives are conducted.

Only ten incidents occurred in the "barmy range" of over 50m (air divers), almost half the number recorded last year. Let us hope this trend (if that is what it is) continues.

TABLE 3

DEPTH RANGE OF INCIDENTS

Depth	Incidents
Unknown	53
Surface*	98
1-10 m	6
11-20 m	28
21-30 m	45
31-40 m	32
41-50 m	9
Over 50 m	9
Total	280

These figures were obtained from a coloured bar graph, which did not translate well into black and white, by measurement of the bar heights and the numbers scale height.
* This figure was obtained from the text.

We categorise incidents under a number of broad headings:

FATALITIES numbered 16, around the average that history prepares us to expect, and each brings great sadness to all involved. Seven were BSAC members, again a typical number.

When did the fatalities occur? Our information indicates that people are perhaps pushing themselves too hard at the beginning of the season, when the water is still cold, and without giving themselves a chance to work up to diving fitness and competence. Build up slowly, give yourself time to regain diving fitness after a winter's lay off.

TABLE 4

UK DIVING DEATHS

Month		Deaths
March	1996	2
April	1996	4
May	1996	4
June	1996	1
July	1996	2
August	1996	2
September	1996	1
Total*		16

These figures were obtained from a coloured bar graph, which did not translate well into black and white, by measurement of the bar heights and the numbers scale height.
* This figure was obtained from the text.

Among half the fatalities there is too little information to determine what caused the problem. Of course, these are the only cases in which the casualty's opinion is unobtainable.

Three deaths involved individuals with prior medical conditions. Where these were known the individuals were clearly taking a risk, but this was not so in all cases. In one incident a diver had a check-up, was given a clean bill of health but suffered a fatal heart attack while diving two weeks later.

Three cases involved divers apparently diving alone. This is particularly relevant in view of the current discussion about solo diving. It cannot be claimed that these divers would all have survived had they been diving with a buddy, but the 20% of fatalities involving solo divers is out of proportion with the number of solo dives conducted.

The report records a number of incidents where divers became unconscious underwater and were safely recovered to the surface by attentive buddies. It is almost certain that these would have added to the fatalities had the divers been alone. As it is, because the outcome was positive they could easily pass unnoticed as relatively minor incidents.

DECOMPRESSION ILLNESS (DCI) is the second biggest category, with 77 incidents recorded. In 40% of cases there is too little information to determine the prime cause, and almost a quarter seem inexplicable; in other words, the dive profile would not have been expected to cause a problem.

These could be cases of patent foramen ovale (holes in the heart) or just reflect that no table or computer guarantees freedom from problems. But I suspect that in many cases the truth is simply stretched. A BHA representative told me that as chamber operators spend time with patients they often admit to features of the dive that relate to the problem but were omitted or distorted in reporting the incident. Few of us like admitting our mistakes.

The next group, just under a quarter, involves cases of DCI where some clear "rule" of safe diving practice has been broken; rapid ascents, missed stops or incorrect repeat dives.

After an initial dive to 18 m which included 12 minutes of training stops, a diver re-entered the water alone to free a stuck anchor. The work caused exertion and the diver surfaced rapidly from 15 m, out of breath. At the surface the diver was distressed. Recompression treatment resolved the problem.

A diver received a spinal bend causing loss of function of the left leg. The incident involved a dive to 62 m, the rescue of an unconscious diver and a rapid ascent. A full recovery is reported.

Two divers completed a dive to 30 m for a bottom time of 35 minutes after experiencing difficulty recovering the shot. The computer of one cleared, but the other still required 5 minutes of stops when they surfaced because of low air and being overdue. One complained of "pins and needles" in his hands and was put on oxygen. He was treated for two hours in a recompression chamber.

In a revealing breakdown of DCI incidents by type, by far the biggest category involves serious cases of neurological DCI, backing up a comment made to me by the BHA that divers are not taking DCI seriously enough. Twenty-five per cent of cases treated result in unresolved problems for the casualty.

TABLE 5

DECOMPRESSION ILLNESS BY TYPE

Type	Number
Neurological DCI	122
Pain and limb DCI	25
Omitted decompression	18
Deaths	15
Unclassified	15
Skin DCI	4
Pulmonary barotrauma	3
Total	202

These figures were obtained from a coloured bar graph, which did not translate well into black and white, by measurement of the bar heights and the numbers scale height. The bar graph obviously covers more than last year when there were 77 cases of DCI.

ILLNESS AND INJURY, here the biggest single group comes under the heading of "bad luck", where it is difficult to see how the problem could have been foreseen or avoided.

Dekitting, a diver was lowering a combined 15 l and pony cylinder to the ground when a clip on his BC broke allowing the set to fall on to his big toe. A double fracture was diagnosed.

Two fully kitted divers were walking towards the entry point for a dive, their route included a series of steps blocked by a group of young children. In trying to negotiate this obstacle one of the divers fell and broke his leg.

During a training session in a pool with a maximum depth of 4 m, a trainee experienced difficulty clearing during a descent. He ascended a little, the ear cleared and the session continued. Six days later, undergoing a diving medical, it was discovered that this diver had a perforated eardrum.

The other group of any significance involved a number of similar incidents where divers were injured by buddies rolling or jumping into the water on top of them. They were stuck on the head and arms, often by the buddy's cylinder. These incidents are potentially serious and totally avoidable.

BOATING/SURFACE INCIDENTS numbered 98, and the major cause forming the biggest single group is lack of, or poor, servicing, leading to engine failure and divers

stranded at sea. If the failure occurs while divers are down, lost divers are likely to be the result.

Seven divers in three groups were diving at the same time, each group with an SMB (surface marker buoy). The engine of the diveboat stalled twice, and by the time it was restarted the second time the cox had lost sight of the SMBs. After a search, the Coastguard was contacted and an inshore lifeboat launched. All divers were eventually found and returned safely to shore.

There are many such cases, and the fact that no lives were lost is down to good luck and the skill of the rescue services.

The next big group involves carelessness from boat-handlers:

Two RIBs were waiting for the last pair of divers to surface when a third boat appeared. The divers deployed a delayed SMB and ascended. One surfaced and the second was just below the surface when the third boat drove over the top of the second diver's bubbles, despite shouted warnings.

Two divers had completed a dive to 30m and were using a lifting bag as a delayed SMB to make their ascent. When they were at 18 m a RIB pulling a shot weight towed the shotline through them, hitting one with the weight. The SMB was ripped out of their hands and they descended to the seabed.

During an ascent from a wreck, at the final stop, a diver was caught by a fishing hook and dragged towards the surface. Every so often the line went slack and the diver sank again. The diver's buddy finally managed to cut this diver free, but a rapid ascent was made to just below the surface, where buoyancy control was re-established.

Another group comes under the heading of poor planning:

Four pairs of divers dived in a cove from the shore. Three pairs returned but the fourth was carried west by the current. A yacht was asked to pick them up.

A car ferry had to take avoiding action for a diver who surfaced in a main shipping lane.

Two divers apparently drifted off a shotline to a wreck and were picked up 2.5 miles from the site by another charter boat. They had no surface detection aids available.

This last issue comes up repeatedly and is easy to resolve. Flares, large inflatable "sausage buoys" and flags are all effective in increasing your visibility to searchers. I find it astonishing that anyone commits themselves to the deep without such a device**.**

FAST ASCENTS have been conducted by divers after they have lost their weight belts; been unable to control drysuit buoyancy; or been dragged up by delayed SMBs and lifting bags.

Two divers were filling a lifting bag at 32 m to help recover a shot. The regulator being used free-flowed, the bag became buoyant and although the diver who had been filling it moved back, it carried him to the surface.

One of a pair of divers tied a delayed SMB line to a wreck and released the buoy in preparation for their ascent. The line did not seem to run freely. It was detached from the wreck but became entangled with fishing line. The line jammed, catching the diver's thumb. Once the line was detached, the diver was pulled rapidly upwards, because the buoy had not reached the surface. The divers were attached to each other by a buddy-line so both were carried to the surface. Their computers indicated that five minutes of stops had been missed.

Two divers ascending from a no-stop dive to 35 m intended to conduct a safety stop of 3 minutes at 6 m. However, one was unable to release air from his drysuit wrist dump and ascended buoyantly to the surface. His buddy went with him. The thermal under-suit is thought to have become tucked up and so prevented the effective dumping of air.

After a 24 minute dive to a maximum of 39 m, a dive trio commenced their ascent. One of them lost control of his buoyancy, because of unfamiliarity with a new drysuit dump-valve, and ascended directly to the surface, missing all planned stops.

Two trainee divers were swimming close to the sea bed in 15 m when the weight belt of one of them became detached, dropped to the bottom and was lost in the silt. This diver alerted the instructor, who tried to assist. Despite dumping air, and with the trainee upside down and finning downwards, they made a buoyant ascent.

Most of these incidents could have been avoided with more care, attention or practice with the equipment.

TECHNIQUE covers a category of incidents in which poor planning features strongly:

Two Coastguard teams were tasked to search for two overdue divers. No dive plan had been logged. It turned out that they had been stuck in road traffic.

Two divers stayed too long at depth, were unable to relocate the shotline for ascent (it had been removed) and had trouble using a delayed SMB. Stops were correctly conducted at 6 m, but at the 3 m stop one diver was almost out of air and used the alternative air source of the other. When they surfaced they had missed 3 minutes of stops, though they had some air left.

EQUIPMENT is the final category and it is dominated by two issues, poor or missing servicing and regulator free-flows, most commonly due to cold water:

A diver's regulator mouthpiece "came apart" underwater. She swam 7 m to her buddy and snatched his regulator, displacing his mask. The buddy used his octopus and adjusted his mask. The defective regulator was then found to be serviceable and the dive continued for a further 30 minutes.

One of a pair of divers experienced a violent free-flow from their regulator as they descended. A second regulator attached to a second cylinder was used, and as the pair were unable to stop the free-flow the first cylinder was turned off. Subsequent examination indicated that this regulator had not received a recommended upgrade, and a mechanical failure had occurred.

Four minutes into a dive, at 17 m, the regulator of one of a pair of divers started to free-flow. Attempts to rectify this underwater failed and the diver made a rapid ascent. Icing of the .first stage was found to have caused the problem.

This latter incident was at an inland site in March. The message is clear: ensure that all servicing is correctly carried out and take precautions against regulator free-flow when operating in cold water.

We all place ourselves at higher than normal risk every time we dive. and things do regularly go wrong. Usually we can correct the situation, but every so often the toast lands jam side down.

I believe we tend to transfer our everyday experience of risk management to the diving situation without realising that the "incident pit" slope is very much steeper because we are in an alien environment.

Boat engine failures are not the same as car engine failures, arriving late at a planned stop is not the same as arriving late for a meeting and in the real world we have an inexhaustible supply of air.

We allow ourselves to be lulled into a false sense of security, allow too small a margin for error or problems, and when things start to go wrong they often develop too fast to cope with. But we could cut the incidents by 50 per cent through:

Thorough and timely equipment servicing;
More care over dive planning;
Building up slowly;
Taking more care with boat handling;
Ensuring we stay within the recommended limits for safe dive profiles.

Brian Cumming is the British Sub-Aqua Club Safety and Incidents Adviser.

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August 29th and 30th 1997
will be hosted by
the Hyperbaric Medicine Unit, Prince of Wales Hospital,
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Royal Australian Navy

Friday August 29th will be devoted to hyperbaric medicine. Saturday August 30th will focus on diving related subjects. Drs Carl Edmonds and Des Gorman are among an impressive list of speakers.

For further details contact
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