

## ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

### UHMS DIVE COMPUTER WORKSHOP

Bill Hamilton

Diver-carried computers (DCs) have been in use for nearly a decade, but their reliability in defining decompression for certain types of profiles remains controversial. A diversified group of experts was assembled for a workshop during the UHMS annual meeting in Halifax, Nova Scotia, to examine in particular the question of repetitive dives. Following up on earlier workshops, one by the American Academy of Underwater Sciences (AAUS) in 1988, which considered rational use of DCs in the scientific diving environment, and one in 1992 by the European Undersea Biomedical Society (EUBS), which looked at a variety of issues, particularly the track record of DCs in recreational diving, the workshop in Halifax addressed the use of DCs in repetitive diving from a variety of perspectives.

Initiating the discussion was an outspoken critic of dive computers, Dr Carl Edmonds from Sydney, Australia. By his calculations, dive computers cause "omitted decompression" when compared to the venerable U.S. Navy Standard Air Decompression Tables. Strictly speaking this is the case, but others point out that this is a consequence of the calculation methods and some inherent conservatism, or inefficiency depending on your perspective, of the Navy tables. Although there are small differences, this critique applies to virtually all present day DCs. In addition to his point about numerical manipulation, Dr Edmonds makes a more relevant point: very few DCs have been tested by the manufacturers before being placed on the market. Some DCs include warnings and suggest procedures for increasing conservatism, but Dr. Edmonds feels these factors should be put into the algorithms rather than be left to the user. One type of profile that he expects will produce greater problems with repetitive dives are closely spaced dives that are relatively deep.

Providing a partial answer to this criticism, Dr. Albert Bühlmann, now retired but formerly at the University of Zurich, described a new model that takes into account the water temperature in computing the decompression. Professor Bühlmann's models are used in several of the current dive computers (as well as in several commercially available PC-based programs that can be used for calculating special decompression tables such as those needed for "technical" trimix dives). Professor Bühlmann pointed out that perfusion changes drastically when a diver is cold, so Dr Bühlmann's model uses a colder water temperature to cut back on the theoretical outgassing rate. The new model also calls for more ascent time from deep dives, which Dr. Bühlmann feels will account for repetitive dives. With the limited ascents it will be difficult to carry out long, deep

dives in cold water because of the longer decompression required.

Max Hahn of the German Sports Divers Federation presented more evidence for potential problems, showing that computers will allow "yo-yo" diving of the type performed by fish farmers, without compensation. He suggests keeping a running account of every msw (metre of sea water) of ascent, and using the total to limit the final ascent. This could be done in a way that would penalise the more aggressive yo-yo dives, but would not inhibit the familiar square and multilevel patterns that seem to be working.

Moving from theory to results, Guy Dear and colleagues of Duke University reported on recent data from the Diver's Alert Network. He noted that more divers are using computers, and compared "table dives" with "DC dives." In the early days of DCs only the more aggressive divers had them, but DC use has spread to the garden variety diver and now more dives are done with computers than without. Even so, the computer dives tend to be deeper, and the divers using computers are more likely to be older and male. The proportion of DCS is higher in table dives than DC dives, but there is no difference in symptom severity; delay until treatment is the same. The data base is not large enough to allow repetitive dives to be evaluated. As with other survey data of this sort, a hard denominator is still missing, (which is why DAN is instituting a massive program to collect accurate dive profiles, Doppler scores, and outcome from a million dives).

Next, Jon Hardy of Avalon, California, reported on a comparative evaluation of available dive computers sponsored by *Rodale's Scuba Diving*. DCs are primarily a tool of recreational divers, and work best for multilevel dives; they uniformly give a more conservative decompression for a "square" dive. The recreational diving community needs to admit that "decompression diving" is being done. Measurements of time and depth are all of excellent quality. Mr. Hardy compared a number of repeated dives, watching when each of the computers would "give up." He offered a list of improvements that dive computer manufacturers could incorporate. Do not switch different types of information in the same location in the graphic display, do flying-afterdiving calculations based on the exposure, and allow the user to add a safety factor. The workshop chairman reminded him of the importance of including a dive logger, with which he agreed.

Bret Gilliam of Bath, Maine, offered suggestions on how to use DCs. He pointed out their excellent information on depth and time and their overall reliability, but also noted that even "no-stop" multilevel diving is a type of decompression. First, a diver needs to know how to use the

computer. Ascent rates need to be controlled and provocative exposures avoided. Limit dives to 2 to 4 per day, with at least 1.5 to 2 hours between them. Novice divers should stick to nostop dives, and all divers should avoid pushing their computer to its limit. No decompression procedure is completely "safe," so include the same sort of buffers or J-factors as one would with tables.

Dr Russ Peterson of West Chester, Pennsylvania, explained how the UHMS Validation Workshop (1989) could be used as guidelines to accomplish some of the dive computer testing called for by Dr Edmonds. Chamber testing may be useful for "disaster prevention," but it is an impractical way to define low predicted DCS incidences at high levels of confidence. If the domain of experience is relevant to the new procedures, then existing experience can be used for validation. Dr Peterson pointed out that a court would consider a "valid" procedure to be one deemed so by experts in the field. This is not a free license and has to be defensible to peers, but it offers another option.

Captain Ed Thalmann of the Naval Medical Research Institute (NMRI) in Bethesda, Maryland, treated this audience to a preview of the algorithm that will be used for the new USN Air Tables, and showed in some detail the clever statistical methods used to develop them. NMRI researchers used extensive chamber testing as well as a massive data base of Navy diving experience as a baseline. Assembling the data base was constrained by several factors: self reporting of outcome was not acceptable and all dives used had medical assessment. The predictive algorithms worked well on dives similar to those in the data base and were satisfactory on some unusual profiles not in the data base. The resulting algorithm is available to a commercial computer manufacturer who wants to develop it in a DC. Comments were hot and heavy throughout the workshop. Some participants mentioned that the training institutions should recognise that divers are doing this type of diving and are using computers. The DCs are not "diver-proof," the human needs to control the device, not the other way around: and avoid "computer narcosis." Workshop chairman, R.W. "Bill" Hamilton, is preparing the workshop proceedings which will be ready by mid-1994.

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## THOSE IN PERIL ON THE SEA...

Tim Parish

More thorough reporting revealed a truer picture about diving incidents around Britain last year. There were at least four incidents every month, rising to a peak of 45 in the summer, many involving boat and surface problems.

Compared with 1992, the 1993 British diving year looks, at first glance, to have been a poor one in terms of safety, with an overall incidents tally of 263, as against 149 the previous year. However, with over 360 reports, covering 263 incidents, the 1993 data shows a higher than average recording accuracy. Last year's data was supplied by the British Isles Group of Hyperbaric Therapists (BIGHT), the Diving Diseases Research Centre (DDRC), the Institute of Naval Medicine (INM) and HM Coastguard, together with the usual British Sub-Aqua Club (BS-AC) Incident Reports.

There was a total of 9 diving fatalities in Britain in 1993, a dramatic drop from the 17 of 1992. Of these, only 3 fatalities involved BS-AC members.

One BS-AC incident involved a branch which was running an introductory diving course at the local swimming-pool. This incident was very upsetting for all members of the club concerned. The deceased man, who died of a heart attack, had enrolled on the course and signed a Declaration of Fitness To Dive. The man was in his mid-30s, overweight, a heavy smoker, and had had two previous heart attacks and a triple heart by-pass operation during the previous 3 years. He hid his operation scars in the changing room and pool by wearing a dark T-shirt. The club itself was found to be blameless in this fatality and the members were actually praised by the rescue services for their attempts to resuscitate the man. This particular fatality highlights the need to ensure that fitness declarations are signed before taking any non-member into the water. Failure to do so could be seen as being negligent, thereby allowing the BS-AC's insurers to withdraw cover.

A female diver (not a BS-AC member) disappeared from the shotline during the ascent from a 56m dive on a wreck off Portland Bill, after having had to abort the dive due to nitrogen narcosis. The woman was carrying oxygen for decompression and it is suspected that she may have breathed from her oxygen cylinder in error during the ascent, causing her to lose consciousness.

The use of oxygen for decompression is not recommended by the BS-AC because of the dangers of loss of consciousness under the surface. Occurrences of this have been recorded by military divers, but even they are not allowed to use oxygen under water without full-face equip-