SPUMS WORKSHOP ON COMPUTER ASSISTED DIVING

THE DEVELOPMENT OF SPUMS POLICY ON COMPUTER ASSISTED DIVING

Des Gorman, Chris Acott and Drew Richardson

Introduction

The SPUMS workshop on computers and diving was conducted at the 1994 Annual Scientific Meeting of the Society in Rabaul, Papua New Guinea. As with the Society's previous workshop on emergency ascent training, the outstanding feature of this exercise was the degree of consensus. Indeed, it was a pleasure to be able to debate issues in diving safety without the acrimony and personal attacks that usually accompany any consideration of recreational diving practice. The latter is, unfortunately, especially true if equipment (and hence commerce) is involved. Again, the commitment of PADI to the workshop was greatly appreciated; it is noteworthy that the 1994 workshop was improved over that of 1993 by the presence of both John Lippmann and Paul Lunn who were able to represent the views of NASDS Australia.

The presentations

All but one of the presentations is published in this edition of the Journal. A review of the kinetics of inert gases in diving presented by Des Gorman is to be published in "Anaesthesia and Intensive Care"so is not available until after publication. Included are personal reports of diving with computers by David Davies and Guy Williams, accounts of current and future diving computer design by John Lippmann, a review of computer assisted diving by Drew Richardson, analyses of diving incident monitoring data by Chris Acott and a pro and con discussion by John Knight. Those from Ray Rogers and Bruce Wienke were not presented at the workshop.

General observations

The workshop accepted at the outset that the use of a diver-carried apparatus that measures depth and time and (from these inputs) calculates decompression requirements (a decompression or dive computer) is not a "passing fad" and will be a feature of recreational diving (and some forms of military and commercial diving) for the foreseeable future. Consequently, the workshop resolved that the Society should establish clear and practical advice for dive computer use and development. The need to establish safe diving practice for divers using dive computers (see comments below) convinced the workshop that the title of both the debate and subsequent policy should be "computer assisted diving".

Despite this acceptance, it is clear that the plethora of data presented to support diving with a dive computer is essentially anecdotal. There are limited objective data for any type of diving exposure and outcome, and these observations are largely limited to square profile diving and not to the multi-level type of diving computation that is intrinsic to diving with a dive computer. It follows that the risks of diving with a dive computer have not been established to any degree of statistical validity. Indeed, the Diving Incident Monitoring Study (DIMS) data suggest that diving with a dive computer may have the same associated risk of decompression illness (DCI) as diving without any form of decompression schedule. Given the reasonable assumption that the extent of the dive is to some degree related to outcome, it is self-evident that a shift from square profile diving logic, in the calculation of the decompression requirement but not in the actual dive, to not only multi-level diving, but also multi-level logic in calculating decompression will often increase the available time for divers underwater and hence the risk of DCI. Extraordinarily, this feature of dive computers, the increased exposure while not mentioning the increased risk, is used as a major selling feature. This criticism of the shift from square profile to multi-level profile logic is not a criticism of dive computers per se, but rather a criticism of one way in which the current generation of dive computers can be used. It follows that any potential buyer of a dive computer must be aware of the following:

a the risk of decompression illness associated with use of the current generation of dive computers has not been established (Divers Alert Network (DAN) data show a steady annual increase in the percentage of DCI that occurs in computer users, however, it is difficult to assess the significance of this without knowing both the percentage and the overall nature of computer assisted dives);

b for a given decompression algorithm and a multi-level dive, calculation of the decompression requirement using a multi-level logic will have a greater associated risk of decompression illness than the equivalent calculation using a square profile logic (see comments about DAN data above);

c the current "safety" of recreational diving has been established by conservative decompression practice and this is threatened by non-selective use of dive computers (see below with respect to the comments about safe diving).

In the context of collecting objective data of the risks associated with recreational diving, there was widespread support for the DAN research project to record the outcome of one million dive computer-monitored dives.

Consequently, it was agreed that a dive computer should be both "down-loadable" and compatible with the DAN database.

It is clearly possible to use a dive computer for multi-level diving in such a fashion that the consequent accumulated exposure constitutes a very high risk for decompression illness. The Workshop was unanimous in support of the need to impose "safe" diving practice on computer assisted divers, e.g. dive planning must have priority, only one dive/day to any depth beyond 30 msw etc. see page 204 for the actual Society policy.

There was considerable discussion on the features that a DCC should have and agreed essential features are included in the policy. There was some disagreement on whether there should be a standard format for information display (analogous to that being introduced for anaesthesia equipment). Despite objections that this would constrain developers of dive computers, it was agreed by a large majority that a common display format (ie. specific information, such as elapsed time, would appear in the same "place" in the dive computer display) was needed to improve the reliability of dive computer use/review by novice divers, divers who have recently purchased a dive computer and dive buddies.

Of major concern was the report that 30% of surveyed divers who used a dive computer had experienced a dive computer failure during a dive. Even allowing for improvements in dive computer design since these data were collected, it is clear that sole reliance on a dive computer can not be advocated and that divers must have access to abort procedures. This again underlines the need for dive planning.

The issue of training was raised in the specific context of: the recreational instructor agencies and general training; the obligations of a retailer of dive computers to purchasers of dive computers; and the obligations of purchasers themselves. Consensus statements were possible and these are included in the policy.

Des Gorman, who chaired the Computer Assisted Diving Workshop, is Director of Medical Services of the Royal New Zealand Navy and the President of SPUMS. His address is RNZN Hospital, Naval Base, Auckland 9, New Zealand.

Dr Chris Acott is the Co-ordinator of the Diving Accident Monitoring Study. His address is the Hyperbaric Medicine Unit, Department of Anaesthesia and Intensive Care, Royal Adelaide Hospital, North Terrace, Adelaide, South Australia.

Drew Richardson is Vice-President, Training, Education and Memberships, PADI International Inc., 1251 East Dyer Road, Suite 100, Santa Ana, California 92705-5605, U.S.A

UNDERSTANDING DIVE TABLE AND METER PROCEDURES

Bruce Wienke

Diving model

Decompression sickness results from excessive changes in ambient pressure over a particular period of time. With simple decompression sickness, bubbles, or some related form of free gas phase, are thought to trigger a complex chain of physico-chemical reactions in the body, affecting the pulmonary, neurological, and circulatory systems adversely. Many factors are relevant to the formation of bubbles, such as gas uptake and elimination in the tissues and blood, gas solubility and diffusivity, tissue vascularity and type, breathing mixture, amount of pressure reduction, temperature, presence of preformed nuclei, and individual susceptibility. To prevent decompression sickness, appropriate diving measures limiting depth, time, and repetitions form the basis of diving tables and schedules, more recently encoded into digital underwater computers.

History

Tables and schedules for diving at sea level can be traced to a model proposed in 1908 by the eminent English physiologist, John Scott Haldane.[1] He observed that goats, saturated to depths of 165 feet of sea water (fsw), did not develop decompression sickness if subsequent decompression was limited limited to half the ambient pressure. Extrapolating to humans, researchers reckoned that tissues tolerate elevated dissolved gas pressures (tensions), greater than ambient by factors of two, before the onset of symptoms. Haldane then constructed schedules which limited the critical supersaturation ratio to two in hypothetical tissue compartments. Tissue compartments were characterized by their halftime, τ, that is, the time required for the compartment to halve (loose) or double (gain) dissolved nitrogen. Halftime is also termed halflife generically for exponential (decay) processes. Five compartments (5, 10, 20, 40 and 75 minutes) were employed in decompression calculations and staged procedures for fifty years.

Some years later, in performing deep diving and expanding existing table ranges in the 1930s, Hawkins and Shilling,[2] and Yarborough[3] assigned separate limiting tensions (M-value) to each tissue compartment. Later in the 1950s and early 1960s, Dwyer,[4] Des Granges [5] and Workman,[6] in addressing repetitive exposures for the first time, advocated the use of six tissues (5, 10, 20, 40, 80 and 120 minutes) in constructing decompression schedules, with each tissue compartment again possessing its own limiting tension. Temporal uptake and elimination of inert gas was based on mechanics addressing only the macroscopic