NITROGEN NARCOSIS

Ken Kizer

Nitrogen narcosis, that prominent effect of the undersea environment that is always talked about in diving classes and is experienced by almost all divers at one time or another, was the subject of a recent two day workshop sponsored by the Undersea Medical Society (UMS) and the National Oceanographic and Atmospheric Administration (NOAA).

The obvious question is: "What was the interest in holding a workshop on nitrogen narcosis? After all, isn't everything important about nitrogen narcosis already known?" Well, soon after the workshop started it became evident that such is not the case. In fact, it became quite clear that very few things about nitrogen narcosis are known with certainty, except, of course, that it occurs.

The primary reason to hold the workshop was to address the potential problems that nitrogen narcosis presents for the scientists and other personnel who will be utilizing the NOAA-sponsored undersea habitat that is to be built at the Catalina Marine Science Centre off southern California, the Western Regional Undersea Laboratory (WRUL), as it is now called.

In the WRUL scientists will live in a specially designed undersea habitat for seven to fourteen days at a time, at depths between 60 and 120 feet, breathing a 50-50 mixture of oxygen and nitrogen (nitrox). They will make air breathing excursions to do work at depths well below 200 feet. Besides the questions about whether subsea scientists can work safely and effectively under these conditions, there is a very fundamental question as to how reliable the data will be which they gather. This is not a trivial question when you consider that the experiments that they will be doing may involve hundreds of thousands of dollars and months or even years of preparation.

Although these questions could not be answered, the participants, under the direction of the workshop chairman Dr Kizer, did review what is currently known about nitrogen narcosis and provided some direction for future research in this area. A full report of the workshop will eventually be published by the UMS, but some of the findings might be of interest to readers now.

The role of nitrogen narcosis in modern diving was characterized as "sand beside the road", meaning that it is not normally a problem because most divers stay out of it. However, it is always a potential problem for compressed air breathing divers, and it is an enormous operational consideration for commercial and scientific diving because of the limitations it imposes on air diving. Indeed, narcosis is the primary (but not the only) reason for limiting the diving depth when using air.

The actual biophysical and molecular mechanism of nitrogen narcosis is yet to be defined, although it is known that the elevated partial pressures of nitrogen found at depth acts in much the same way as the anaesthetic gases that are used in surgery, that is, the nitrogen blocks conduction of impulses along nerves.

Of course, the major questions considered at the workshop related to how much nitrogen narcosis influences performance and what can be done to moderate its deleterious effects. Although workshop participants reviewed the scientific literature on this subject, it rapidly became clear that much has yet to be studied. Most of the studies that have been done to date have looked at the effects of narcosis on the performance of single, relatively simple jobs that do not require the diver to deal with distractions or to perform complex tasks involving multiple simultaneous or sequential functions. Similarly, very few studies have investigated the effect of narcosis on overall perception, memory, or integration of multiple bits of information. Obviously, much needs to be done in this regard, some of which would be directly relevant to recreational divers, especially with regard to the role of narcosis in sport diving accidents.

One investigational methodology for future nitrogen narcosis studies that was discussed in some detail was the possible use of video games for hyperbaric chamber experiments or for making daily assessments of diver performances and acclimation in the undersea habitat. These have a number of potential advantages over traditional psychological and performance tests. For example, video games can easily record, store, and analyze test scores; they are self-motivating, and they require only a modest amount of training. Who knows, underwater Pac Man may be just around the corner.

Another topic that received a lot of discussion was the phenomena of "adaptation" to nitrogen narcosis; that is, the process of a diver seemingly becoming less and less susceptible to the effects of nitrogen narcosis after repeated exposures during a short time period. (Unfortunately, this is not a permanent effect.) This process has been variously called adaptation, acclimation, acclimatization, tolerance, accommodation and other things, but it was agreed upon at the workshop that the correct term that should be used in the future was "acclimation".

Although the effect of acclimation has been repeatedly observed, many questions remain. Is this just a behavioural adaptation or is there really a physiological change? Is it merely a matter of learning to cope with the environment, ie a matter of learning to cope with "underwater stress"? Does this occur more easily in some divers than others? Can the process be speeded up by performing certain pre-dive activities? This list goes on. Unfortunately, no definite answers are available at this time to these or other important questions.

On a related subject, though, one of the things that was evident from reviewing the role of nitrogen narcosis in diving accidents was that it is a frequent contributing factor, although rarely are accidents caused solely by narcosis. It seems to play a major role in causing accidents in which the diver has to deal with some emergency or unplanned situation. The solution to this problem seems to be in overlearning essential skills under controlled conditions. There is a clear message here for training programs, which is just as relevant to sport divers as commercial divers.

A number of other topics are also discussed at the workshop and several recommendations were made for future studies on the subject, but space does not allow for discussion of these things here. They will be detailed in the forthcoming workshop report. In the meantime, though, a detailed bibliography of essentially everything that has ever been written in the English language on the subject of nitrogen narcosis is available from the Undersea Medical Society.*

* Nitrogen Narcosis - A Bibliography with Informative Abstracts. Undersea Medical Society, 9650 Rockville Pike, Bethesda, Maryland 20814, USA. US$8.00

AIR EMBOLISM OR DECOMPRESSION SICKNESS?

A CASE FOR DIAGNOSIS

John Knight

A 27 year old male diver with the proper training was diving at a sinkhole. He states that he did a dive to 34 m for 14 minutes which he said was within the USN No-decompression limits. He went to between 110 and 120 feet, 33-36 m, and should have used the greater depth which means that he overstayed the USN no-decompression limit by 2 minutes. However he did a 5 minute decompression stop at 3 m as a precaution, which took him inside the USN requirements for his dive. He said that he felt stressed by the dive and the water was cold (12°C). As soon as he was out of the water he stripped off his wet suit and went to stand in the sun to warm up.

10 to 15 minutes after surfacing he noticed that his "peripheral vision was dark" (his own words). Within 15 minutes his vision had returned to normal.

Interestingly he commented that an instructor acquaintance of his had noticed this phenomenon on more than one occasion after diving in sinkholes.

When seen and examined a month later he had no neurological deficit. He had worked out this his symptoms were due to cerebral anoxia and wanted to know whether they were due to air embolism or decompression sickness.

Retrospective diagnosis of a transient symptom is always difficult. Here we have to decide between two potentially lethal diagnoses, one of which would bar further diving.

I think that he did not suffer an air embolus due to pulmonary barotrauma. He made a normal ascent, with a decompression stop, and was breathing in and out all the time. His symptoms came on when he was rewarmed, at least 10 minutes after getting out of the water, if his story is correct. So I think that pulmonary barotrauma is very unlikely.

However, there is no doubt that he did have cerebral circulatory insufficiency for a while. Again his normal ascent and decompression stop makes arterial bubbles due to a rapid ascent unlikely, and if he had generated arterial bubbles by rapid ascent one would expect the immediate onset of cerebral symptoms, not a delay of 10 to 15 minutes. Perhaps he could have developed bubbles in his brain which compressed blood vessels leading to ischaemia of the visual pathways, but that does not seem very likely.

My bet is that as he warmed up he restored the circulation to his limb muscles and fat, which had closed down, in response to the cold stress of his dive, after he had loaded these tissues with extra nitrogen early in the dive because he was nervous and overbreathing. As a result bubbles formed in his limb capillaries and were carried to his lungs. Some bubbles bypassed the lung capillary filter, entering arterio-venous shunts and reached the left ventricle and so the aorta and the cerebral circulation.

This would then be a case of decompression sickness presenting as cerebral ischaemia.

Have any of our readers got alternative explanations? If you have please put pen to paper or finger to typewriter.

UNSCRAMBLING HELIUM SPEECH

A group of scientists at Edinburgh University, under their director Dr David Milne, have developed a range of "helium speech unscramblers" capable of taking the diver's "quacking" noises and converting them into recognisable speech on the ship, an invaluable service to the Dive Supervisor and his team. Dr Milne reports that the unscrambler has been tried out in the North Sea work situation for over a year. There are at present two systems in use, a big system for use by a diving company and a smaller system. The former has seven unscramblers, loudspeakers, and tape decks for entertainment circuits and costs about $35,000. The alternative system provides divers' radios which contain a simple unscrambler and a three-person communication, cost about $4,000.

Dr Milne is also working on the development of a through-water, diver-to-diver communication system. This project will employ a more advanced technology than the unscrambler both being based on special circuits which use commercial "charge coupled" devices. Essentially both do the same thing, taking the distorted "helium speech" and storing it for a few milli-seconds before playing back the corrected speech sounds. He is certain that the through-water systems will become increasingly important as they become more sophisticated and flexible. The potential market is large for use in both civil and military diving. Manufacture is now in the hands of Findlay Irvine and sales through Underwater Instrumentation of Aberdeen and London.