Technological advances in scuba diving do not always increase safety

Annually in the United Kingdom there are 10–20 deaths of sport divers. In half of the cases, inadequate information or failure to recover the body prevents determination of the cause of the accident.¹ When causes are known, cases are equally divided between deaths due to coincidental medical conditions (usually cardiac) and cases where divers drowned because they failed to follow recommended safety procedures—for example, solo diving and wreck penetration without running a safety line to enable the return route to be traced—or because of equipment failure. Decompression illness rarely results in death, but can cause serious neurological illness, including paraplegia. There are about 100 cases requiring treatment annually.^{1,2} Information collected by the British Sub-Aqua Club suggests that there are a larger number of mild cases where treatment is not sought. Some cases of decompression illness are also the result of predisposing medical conditions and others result from poor technique.³ There is evidence that some cases are caused by malfunction of equipment designed to prevent decompression illness.

The technological sophistication of sport diving has increased with the popularity of the sport. Most sport divers now use one of a large variety of decompression computers meant to reduce the chance of divers suffering decompression illness. Decompression illness has four principle manifestations: cardiorespiratory (chest pain, dyspnoea, cardiogenic shock) which is rare but may be fatal; neurological, which is common in sport divers and may leave permanent sequelae including paraplegia; joint pains, which is more common in caisson workers; skin rashes. It has long been known that the risk of decompression illness increases with the depth and duration of the dive. Observations of rates of decompression illness (in military and commercial divers) after particular depth-time profiles allowed development of mathematical algorithms, which give an “acceptable” risk of decompression illness. Acceptable risk varies with the situation—for example, military use in wartime versus recreational use—and from person to person. There are therefore a large number of algorithms. At one time, these were incorporated in waterproof tables which divers took underwater. A diver could usually determine the relative safety of two tables by seeing which imposed the greatest decompression penalties for a particular dive. To determine his decompression stop requirement from the table, he looked up his maximum depth and bottom time, which were read from his depth gauge and watch. The accuracy of each could be checked easily. That has all changed. A decompression computer continuously collects information about depths and times and uses these data in a calculation based on the incorporated decompression algorithm to advise the diver on his decompression stops. It replaces the diver's watch, depth gauge, decompression tables, and sometimes common sense. Decompression computers are complex black boxes. It is not always obvious when they malfunction. It is not easy to check whether they are measuring time and depth correctly. It is almost impossible to know during a dive

whether the decompression calculation based on the measurements is being performed properly. Because of commercial secrecy, the precise details of some algorithms are not published, so divers cannot tell which are the safer ones. However, we know that, if a test dive is performed with various makes of dive computer, they will advise greatly varying decompression profiles.⁴ They cannot all be equally safe. Nevertheless, one might presume that, if two divers perform the same dive and one is using a table and the other a computer program based on the same decompression algorithm, they would come to the surface at the same time. This is not so, and the computer will invariably allow a less conservative profile. To perform decompression based on a table, one must assume that the whole dive has been performed at the deepest depth. This adds a safety margin. If it is working properly, a computer calculates that most of the dive was shallower than the maximum depth and integrates the algorithm to maximise time underwater. This way the computer allows the diver to maximise the chance of getting decompression illness on every dive.

A popular decompression computer model has recently been withdrawn because of unreliable operation.⁵ I have seen three cases where the stories suggested that other makes of computers malfunctioned. In each case the diver had decompression illness after a dive within “safe profiles” according to the computer. None of the divers had any of the recognised physical causes of decompression illness.³ Each did a dive that required long decompression stops according to decompression tables (checked later), but their computers permitted them to go directly to the surface or required only a brief stop. One diver tested his computer in a hyperbaric chamber against seven identical models on a dive profile similar to that on which he had suffered decompression illness. His computer indicated that it was safe to surface when all the others of the same make required eight or nine minutes of stops. The other two divers also had their computers chamber tested and their computers required considerably fewer stops than those that they were tested against. Two of the divers sent their computers back to the manufacturers. The makers replied that no fault had been found with the computers, but that they had accidentally been broken during testing, so the diver was sent a new replacement. We live in a technological age, but scepticism about the infallibility of some types of computer may be healthy.

PETER WILMSHURST

Consultant Cardiologist, Royal Shrewsbury Hospital,
Shrewsbury SY3 8XQ, United Kingdom

- 1 Cumming B. When things go wrong: BSAC incident reports 1996. *Diver* 1997;**42**(2):62–4.
- 2 Wilmshurst P, Allen C, Parish T. Incidence of decompression illness in amateur scuba divers. *Health Trends* 1994;**26**:116–18.
- 3 Wilmshurst P, Davidson C, O'Connell G, Byrne C. Role of cardiorespiratory abnormalities, smoking and dive characteristics in the manifestations of neurological decompression illness. *Clin Sci* 1994;**86**:297–303.
- 4 Bantin J. Learning curve. *Diver* 1997;**42**(10):50–4.
- 5 Anonymous. Aqua-lung recalls Monitor 2 Plus. *Diver* 1997;**42**(10):71.