

招待講演 2-1

Diver Risks and Fatalities

Peter B. Bennett, Ph.D., D.Sc.

Executive Director, Undersea and Hyperbaric Medical Society
Emeritus Professor Anesthesiology and Director,
Hyperbaric Center, Duke University Medical Center
Found and 1st President, Divers Alert Network

Diving is a very popular sport and is involved commercially for offshore oil production and other underwater work. This paper will restrict itself to breath-hold, scuba and technical divers using rebreather equipment. Such exposure to the underwater environment carries a degree of risk for injury or even death.

On average in the USA, there are about 90 deaths per year and some 424 injuries. Such diving accidents are predictable. There is often little supervision with errors in judgment; dependence on equipment for breathing and buoyancy; lack of experience and inadequate training coupled with a lack of fitness for diving; cardiovascular disease risk in many of the over 40 year olds diving today and the unusual environment conditions due to exposure to the underwater environment.

Panic Very often an accident is preceded by a diver being stressed for some reason, culminating in a panic reaction. The stressors may be physical, equipment related or psychological. Physical stressors include cold water, fatigue, lack of fitness and breathing constriction from badly fitted equipment. The equipment also may be poorly maintained or malfunction. The diver may be over weighted, affecting buoyancy and ability to swim. Equipment may be lost, such as a fin or mask. Most important and all too common as a cause during the dive, there may be poor monitoring of air left in the tank. Too many divers die due to empty air tanks. The environment itself adds to the potential risks. Conditions such as diving in rough seas, low visibility, the first night dive or the first deep dive and strong currents are especially disturbing and can induce panic. Psychological causes involve the need to carry out too many tasks at once; buddy diver dependence; diving beyond personal performance limits and today, alcohol and drug use.

The solution to panic is to understand these stressors and if this occurs stop, rest and assess the situation and only then act. However, it is often very difficult to break the panic cycle one it is initiated.

Breath-hold Divers There is considerable interest in breath-hold diving without breathing apparatus, including attempts to break depth records over 600 ft. Again, the fatalities are due to a number of causes. Entanglement is a too common cause, either in kelp seaweed, spear fishing line or anchor lines.

Boat interactions include being hit by a boat whilst on the surface even though dive flags can be seen. Dive animal interaction is another hazard including shark attacks, jelly fish stings or sting ray attacks and moray eel bites.

Solo breath-hold diving is a contributory cause due to lack of immediate assistance. The greater the depth, the more difficult the rescue. Safety is to have a person on the surface equipped with scuba ready to dive as a safety diver. Excessive hyperventilation too is a common cause of loss of consciousness due to hypoxia ascending after a breath-hold dive. Failure to ditch the weight belt also is common for all kinds of diver accidents. Such cases can occur even when only snorkeling and may, like all forms of diving today, involve a cardiac related problem in an older diver.

Fig 1. Breath-hold and Snorkeling Fatalities Australia 2006

10 Cases Snorkeling
6 Cardiac Related
3 Asphyxia
1 Animal

Scuba Divers

Fig 2 shows the incidence of fatalities of USA and Canadian scuba divers¹. In early years the number of deaths proportional to the number of divers was high. It is now reduced to an average of around 90 per year with a greater emphasis on divers using rebreather equipment.

Fig 3 shows the distribution by age of diving deaths. It is pertinent that 82% of the females and 72% of the males were 40 years old or older. Further, the most frequently reported medical conditions were heart disease and high blood pressure.

Depth does not appear to be a critical issue. The median reported depth of underwater deaths was only 65 ft. The distribution is shown in Fig 4. However, the depths of 221-240 ft are related to divers using rebreather equipment, which will be considered later and often do involve greater depths.

The reported cause of death in these diving accidents in the 2008 DAN report are shown in Fig 5.

Rebreather Fatalities There have been an increasing number of fatalities in divers using rebreather equipment. The equipment is complex and requires considerable extra training after strong confidence as a scuba diver. Diving beyond recognized recreational diving limits of 130 ft is common. Most of the deaths are due to human error, such as starting the dive with electronics off, incorrectly packed CO₂ canister, exceeding CO₂ canister limits, temporary flooding of unit, inability to maintain constant PO₂, divers descending with diluents off, etc.

A minimum of 50-100 hours training is advisable with a high degree of discipline, regular use of checklists and constant maintenance of the equipment.

Conclusions Diving overall is generally considered a safe sport. The risks vary with the type of diving and depth. A diver needs to be medically fit, especially from a cardiac viewpoint and always dive within his or her capabilities. In that regard, the diver should be well trained in the equipment used and dive conservatively.

Recognition of the potential underwater hazards discussed and the ability to handle emergencies they may cause can materially help to reduce fatalities. Always plan your dive, check your and your buddy divers equipment before the dive and your dive plan.

References Annual Diving Report 2008 Edition. Divers Alert Network, USA.

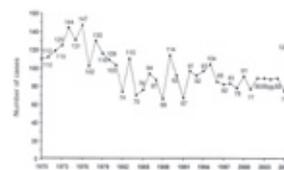


Fig 2. USA & Canadian Scuba Fatalities

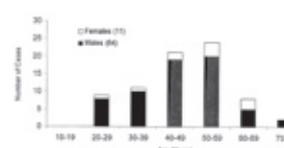


Fig 3. Distribution of fatalities by age and gender

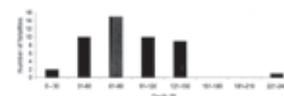


Fig 4. Maximum depth of accident dive (n=48)

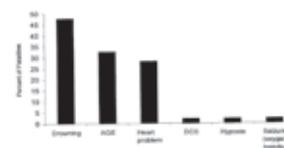


Fig 5. The distribution of the disabling injuries (n=46)