

Warm up

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## The Big Blue

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In October 2002, Audrey Mestre both set a world record for free diving and died in an attempt to extend it further. This extreme sport is fascinating for sports physicians as it represents a very practical demonstration of pulmonary physiology.

Free diving was made popular by the 1988 French film, *The Big Blue*, which was inspired by real events and featured spectacular underwater cinematography. Currently there are more than 20 000 free divers worldwide and the numbers are growing. The International Association of Free Divers (IAFD) based in Miami, USA oversees the sport and certifies world records.

Most free divers use the "constant ballast" technique in which divers use fins but no extra weights to dive as deep as possible before coming up for air. "No limit" free divers take it further by using a metal sled (weighing 90kg) that slides down a vinyl coated steel cable. When the diver wishes to ascend, he or she releases an airbag at the top of the sled that shoots the diver back to the surface. Due to the relatively short submersion time, decompression sickness is not normally a problem although the effects of rapid pressure changes on air-fluid interfaces in the body may result in the same spectrum of problems seen in compressed air divers. Fewer than two dozen elite athletes compete in the "no limit" extreme category attempting to push the boundary of human performance ever further.

Mestre was attempting a no limit world record in the ocean off the Dominican Republic, having completed a practice dive to the remarkable depth of 171 metres. This performance was posthumously recognised by the IAFD as a new world record. In her formal record attempt she reached the depth of 171 metres after 1 minute and 42 seconds and then attempted to inflate the air bag. The circumstances after this stage are unclear but her ascent was delayed. She was pulled from the water after 8 minutes and 40 seconds by her husband (also a noted free diver and holder of the former world record of 162 metres set in January 2000). Attempts to revive her failed and an autopsy noted the cause of death as drowning.

IAFD President, Carlos Serra who was present at the record attempt, claimed that the airbag failed to inflate properly and Mestre appears to have become unconscious at 121 metres and fallen from her sled. A video camera was apparently attached to the sled to record the attempt, however the video footage from this has not been released.

This sport demonstrates the envelope of human performance that is achievable in a hostile environment. Man is poorly adapted for diving, relying principally on lung oxygen stores during breath hold diving. The diving bradycardia that accompanies this process (Mestre's heart rate at 171 metres was apparently 20 beats per minute) is not accompanied by the

important metabolic and other circulatory physiological changes that characterise the full diving reflex in diving mammals. The evidence that there is a physiological adaptation to habitual breath hold diving is inconclusive and it is more likely that the psychological desire to override the "break point is the primary change. Presumably this is how the Ama and other people around the world involved in diving for sponges or pearls achieve their performance

Animals such as deep diving whales and the physiologically remarkable Weddell seal (23 minute dives at 230 metres have been recorded!) have a number of physiological adaptation that mean that their performance is achieved with minimal or no lung volume and without the risk of inert gas narcosis or decompression sickness. Terrestrial animals, including humans are mostly limited by oxygen stores that mean the risk of "shallow water" blackout is extremely high during ascent from breath hold diving as the arterial oxygen saturation drops below the critical threshold for consciousness, which is in the range of 25–30 mm Hg. Hyperventilation prior to a breath hold dive increases this risk as the respiratory drive is diminished. Because of the rapid drop in arterial oxygen at the tail of the oxygen dissociation curve, the margin of safety is extremely narrow resulting in an often fatal shallow water blackout despite achieving phenomenal physiological performance.

Although the remarkable record achieved by Mestre demonstrates the envelope of physiological performance fairly dramatically, I have no doubt that other free divers will attempt to break it. Such is life.

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