The Editor’s offering

A fatality documented in the 2006 Australian scuba fatalities (SC 06/03) illustrates graphically how a series of events and factors lead to a tragic outcome. In teaching about diving safety, I have used the Swiss cheese analogy since the mid-1970s. Imagine a block of Swiss cheese with its characteristic holes. For a serious diving accident to occur, one must break through from one side of the block to the other. The thickness of the block represents the ‘flexibility’ of the system, i.e., ‘safety in depth’ – personnel, training and experience, equipment, built-in redundancy in safety procedures, diving environment, support systems, etc. The thinner the block the fewer things need to go wrong for a serious breach of safety to occur. The holes in the cheese are individual breaches of safety procedures or unexpected events. Individual holes may not lead to an accident, but with increasing breaches – either in number (more holes) or severity (larger holes) – the block may be breached through: a life-threatening or fatal incident. Sometimes known sequences of events lead more rapidly to serious accidents; here the holes in the cheese line up from one side of the block to the other.

A more practical approach is ‘root cause analysis’ (RCA), as used by Lippmann et al. Many different techniques of RCA are described in the literature and summarised usefully in Wikipedia. Without knowing the root cause, the chief goal of this type of analysis – preventing similar accidents by appropriate corrective action(s) – cannot be achieved. One of the simplest structures for conducting this analysis is to consider issues related to people, policies, procedures and equipment. In the case of SC 06/03 deficiencies in all four areas are identifiable, and this tragedy exemplifies that there are often several root causes of a problem or event. In this case, many factors preceded the ‘trigger’ of entrapment leading to running out of air, as listed in Table 3 (page 82): victim inexperience and lack of familiarity with, failure to check pre-dive and inability to correctly operate his equipment; poor dive planning (failure to identify underwater hazards the lifelines might snap on, and defective equipment – an empty lift-bag tank); bad decision making and poor control of the dive by the supervisor; and poor dive practices, such as poor tethered diving technique to allow entrapment (on the part of both the victim and his surface attendant) and failure to have a standby diver kitted and ready to enter the water. The block of cheese was indeed full of holes.

Another issue raised by the 2006 and by previous Australian reports is the question of the adequacy of supervision of the Great Barrier Reef (GBR) snorkelling experience. Far too often in these reports there appears to be a failure on the part of designated safety lookouts to identify swimmers in trouble (BH 06/05 and BH 06/06) or even to realise that someone is missing (BH 06/03). Often, large numbers of inexperienced and sometimes elderly snorkellers are watched by only a few staff and there is not always a means, such as a small tender deployed in the designated snorkelling area, of rapidly reaching the victim when a problem is identified. This results in delay to effective resuscitation, which inevitably reduces the likelihood of its success. Whether or not some of these cardiac deaths were inevitable, it seems to this writer that fresh ideas are needed to help reduce the incidence of injury on the GBR.

In a preliminary study on the impact of prolonged breathhold and depth (pressure) on pulmonary diffusing capacity of carbon monoxide (DLCO) and nitrous oxide (DLNO), Garbella et al suggest that they have demonstrated evidence of what they term alveolar-capillary membrane “distress”. The lung has only a limited range of responses to hydrostatic or other injury, with initial capillary leak leading to increased extravascular lung water. This, in turn, may be followed by transudation of fluid (with a variable protein content) into the alveoli (pulmonary oedema), loss of surfactant, cellular infiltration and, if unresolved, acute respiratory distress syndrome. Extravascular lung water is currently measured using thermal or osmotic dilution techniques, so the simultaneous measurement of DLCO and DLNO is a surrogate for this. In the healthy lung, lymphatic function is highly dynamic and increased lung water is rapidly mobilised. It may well be that what has been observed here can be explained on a physiological basis of increased pulmonary blood volume and lung compression due to pressure leading to a transient increase in interstitial lung water, which is then rapidly mobilised by the pulmonary lymphatics after the dive. It will be most interesting to see where this line of investigation leads.

References


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The front page photo shows the helicopter transfer of a diving emergency from the Scottish Outer Hebrides being received at the Dunstaffnage hyperbaric facility, near Oban. Morvern Hills and the Isle of Lismore in the background.