

Editorial

Decompression illness in children

Christopher J Acott

Smerz's article¹ in this issue highlights several controversial topics related to children: the risks associated with scuba diving; informed parental consent; 'medical fitness' of asthmatics to dive; psychological 'fitness', what treatment pressure is needed and whether there is a need for alternative treatment tables for children and their susceptibility to pulmonary oxygen toxicity.

The physiological, physical and psychological problems/risks associated with children scuba diving have been documented and discussed previously.²⁻⁴ The risks are inconclusive due to a lack of substantive data; however, it is disturbing that in this small series a 15-year-old was left with neurological sequelae (lack of bladder control) which may lead to immense psychological and emotional trauma in later years. Although statistically a rare occurrence, I suggest this fact would be of little comfort to the patient or parents.

Smerz's case histories illustrate that little was discussed with the parents prior to the children scuba diving, and that truly informed consent could not have been made. Twenty-seven per cent of children were known asthmatics; indeed, one had a previous neurological event on a dive. Would parents allow their asthmatic children to dive after the physical laws governing gas compression and expansion and the possibility of pulmonary barotrauma or cerebral arterial gas embolism were explained to them? In addition, one adolescent was diagnosed as suffering from Attention deficit hyperactivity disorder (ADHD) and another from an anxiety disorder. Whether medicated or not, adolescents diagnosed with ADHD, the triad of inattention, impulsivity and hyperactivity, or suffering from an anxiety disorder are psychologically unsuitable for diving.⁵

Both Walker's and DAN's data show that the risk of dysbaric disease or injury is the greatest in the less experienced divers, and this was verified by Smerz's data, which also showed that the mistakes made by children are similar to those reported by adults.^{6,7}

By 1939 recompression had become the accepted method of treatment for decompression illness but there was disagreement concerning its application and today this controversy persists.⁸ The treatment tables used in these cases are unique to Hawaii. Previous published data by Overlock et al showed a decrease in 'failure rate' of these deeper treatment tables (1.6%) when compared with standard practice of the minimum pressure oxygen treatment tables (US Navy treatment table 6 (USN T6) or Royal Navy table 62 – 4.8%).⁹ Smerz again claims a better resolution rate. However, the numbers were small in both reports and are not significant. At a pressure of 777 kPa breathing a nitrox

mixture containing 282 kPa of oxygen would subject the patient and attendant to a narcotic pressure of nitrogen of 495 kPa which would cloud judgement and interpretation of signs and symptoms. Under these conditions accurate self-assessment or assessment by an attendant is doubtful and at best would be extremely crude. It would be interesting to see data on their attendant decompression illness rate.

The evidence level of clinical efficacy for these tables at best would be Class 2B with a level of evidence of C, while for USN T6 it would be Class 2A with a level of evidence of B.¹⁰ Many hyperbaric units would be unable to deliver the treatment pressures used in Hawaii in any case. Perhaps the most important aspect of all recompression regimes is the time spent breathing hyperbaric oxygen. However, even in the use of hyperbaric oxygen there is no agreement concerning what partial pressure should be used.¹¹ A workshop on all the treatment tables, how or why they work and the data substantiating them is needed, although outcome data have been and still are antedotal and are based on different variables and largely from retrospective studies such as this one.

Twenty-three per cent of Smerz's patients developed pulmonary oxygen toxicity during treatment. Individual variation to oxygen toxicity has been known for many years but Ambriz et al suggested that children might be more susceptible to pulmonary oxygen toxicity based on physiological arguments and two case histories.¹² Therefore, they suggested modified treatment tables for children. Smerz refutes this showing that there was no difference statistically in the incidence of pulmonary toxicity between adults and children treated in the Hawaiian recompression chamber. More data are needed.

In Australasia a diving medical is required before participation in recreational scuba diving. At a diving medical for a child or adolescent I insist that the parents are present and explain to them:

- the unknown risks associated with scuba and why
- the lack of data regarding children due to relatively few children having participated in scuba diving in the past 40 years
- the physical, psychological and physiological changes that occur in childhood and adolescence and how and why these may impact on diving
- the morbidity associated with scuba diving, but explain that serious complications are rare and why various medical conditions may lead to morbidity or death
- data show that inexperienced divers (< 20 dives) are prone to injure themselves
- equipment requirements will change as the child matures, and the costs involved
- 'water skills' are an important part of safety and that these should be attained before diving.

References

- 1 Smerz R. Epidemiology and treatment of decompression

- illness in children and adolescents in Hawaii, 1983 – 2003. *SPUMS J.* 2005; 35: 5-10.
- 2 Cvitanovich A, Langton, P. Children and scuba diving. Editorial. *SPUMS J.* 2003; 33: 74-5.
 - 3 Walker R. How old is old enough? *SPUMS J.* 2003; 33: 78-80.
 - 4 Vandenhoven G, Collard F, Schamp E. Children and diving: medical aspects. Eight years sports medical follow-up of the first scuba diving club for children in Belgium. *SPUMS J.* 2003; 33: 70-3.
 - 5 Newton-Howes G. What happens when children with attention deficit/hyperactivity disorder grow up? *J Royal Soc Med.* 2004; 97: 531-5.
 - 6 Walker D. *Australian diving deaths 1972 - 1993.* Melbourne: JL Publications; 1998.
 - 7 Vann RD, Denoble PJ, Uguccioni DM and others. *Report on decompression illness, diving fatalities, and project dive exploration: DAN's annual review of recreational scuba diving injuries and fatalities based on 2003 data.* Durham: Divers Alert Network; 2004. p. 46-77.
 - 8 Yarbrough OD, Behnke AR. The treatment of compressed air illness utilizing oxygen. *Journal of Industrial Hygiene and Toxicology.* 1939; 21: 213-8.
 - 9 Overlock RK, Arnold AA. Dysbaric disease: A Hawaiian experience. In: Bennett PB, Moon RE, editors. *Management of diving accidents.* Bethesda: UHMS; 1990. p. 266-74.
 - 10 American Heart Association Guidelines for clinical efficacy. In: Moon R, editor. *Adjunctive therapy for decompression illness.* Kensington: UHMS; 2003. p. 18.
 - 11 Thalmann ED. Principles of US Navy recompression treatments for decompression sickness. In: Bennett PB, Moon RE, editors. *Management of diving accidents.* Bethesda: UHMS; 1990. p. 194-221.
 - 12 Ambriz G, Abarca M, Torp K. Children treated for DCI and pulmonary oxygen toxicity. *Undersea Hyperb Med.* 2003; 30: 240.
- Christopher J Acott*
Hyperbaric Medicine Unit, Royal Adelaide Hospital,
Adelaide, South Australia 5001.
Phone: +61-(0)8-8222-5116
Fax: +61-(0)8-8232-4207
E-mail: <cacott@optusnet.com.au>
- Key words**
 Children, decompression illness, decompression sickness, medicals/diving, editorial
- (Acott CJ. Decompression illness in children. *SPUMS J.* 2005; 35: 2-3.)

Dr Smerz replies:

Whilst I am pleased to observe the interest in our 'Hawaiian deep tables', I am surprised at the amount of focus they receive from Acott in his editorial. The paper is not an apology for their employment or their efficacy. I do not challenge the substance of his comments at this time as we anticipate publication of a more definitive exposé of our treatment tables in *Undersea and Hyperbaric Medicine* later this year, which may alter his currently expressed opinion regarding their efficacy. However, I am not certain that they are germane to the thrust of this article.

My purpose in specifically demonstrating the tables we employed, which admittedly are more aggressive than most, was to show that longer exposure times to increased partial pressures of oxygen did not result in an increased incidence of untoward effect. One might reasonably conclude that our tables ought to produce potentially higher rates of complications than those employed by most others. Were that the case, and it appears not, then those using less aggressive tables might still have reason to question the need for table modification. Our results, therefore, should provide some reassurance that adult treatment tables are not imposing undue harm and result in substantial recovery. Our most optimal outcome of complete resolution, obtained using the present and most commonly employed treatment tables, has been achieved in only 70% and 75% of cases treated, and has remained steady at this rate over some period of time.¹ To risk obtaining less adequate results by

abandoning the current, time-established tables in favour of an unproven regimen with no substantiated reason to do so invites ethical concerns.

Because of the small size of our study group, care must be exercised when looking at percentages as they tend to artificially magnify a problem. That is why in epidemiological analyses, rates are generally preferred and present a view that is more meaningful. Twenty-three per cent of our cases (five patients), as Acott points out, developed signs of pulmonary oxygen toxicity. However, it is the total number of risk exposures to increased partial pressures of oxygen (62) which is the appropriate epidemiological denominator, and hence an incidence rate of 8%.

Finally, since Acott raises the question, our incidence rate for attendant decompression sickness during the time frame 1983–2003 was 0.1% (3/2,854 exposures). We typically employ three attendants at different intervals throughout the treatment for the deep tables and two per treatment for the 283 kPa table. We decompress all attendants on oxygen using the RNPL decompression tables for tenders.

Reference

- 1 Moon R. Requirement for adjunctive therapy in recreational diving. In: *Adjunctive therapy for decompression illness.* Kensington, MD: UHMS; 2003. p. 77.