

- 5 Wenzel JR *Emergency Ascent Training. 15th Undersea Medical Society workshop.* Ed Kent MB. Bethesda, Maryland: UMS, 1979: 81-84
- 6 Provisional Reports on Australian Diving Related Deaths 1972-1991. *SPUMS J* various dates (consolidated report in preparation)
- 7 Harpur GD. First Aid Priorities for Divers, the Tobermory Viewpoint. *SPUMS J* 1993; 23 (4):198-205
- 8 Acott C. Out-of-air ascents from the Diving Incidents Monitoring Study. *SPUMS J* 1993; 23(4); 222-230
- 9 Smith RW. *Emergency Ascent Training. 15th Undersea Medical Society workshop.* Ed Kent MB. Bethesda, Maryland: UMS, 1979: 9
- 10 Miller JW and Nemiroff MJ. *Emergency Ascent Training. 15th Undersea Medical Society workshop.* Ed Kent MB. Bethesda, Maryland: UMS, 1979: 10
- 11 Dugan J. *Man explores the Sea* Pelican Books, 1960: 128-130
- 12 *RAN Diving Manual* 1990 155 #841-845
- 13 Knight J and Williams G. A medical view of Emergency Ascent Training. *SPUMS J* 1993; 23(4): 230-235
- 14 James RE. *Extra-alveolar air resulting from Submarine Escape. Naval Submarine Medical Centre Report 550.* 1968
- 15 Ingvar DH, Adolfson J and Lindemark C. Cerebral air embolism during training of submarine personnel in free escape : an electroencephalographic study. *Aerospace Med* 1973; 6: 628-635
- 16 *BS-AC Diving Incidents Reports*, presented at the Diving Officers' annual conferences 1979-1993, later printed in *Diver*.
- 17 Richardson D. Current philosophy and practice of emergency ascent training for recreational divers. *SPUMS J* 1993; 23 (4): 214-222
- 18 Harpur GD. A new approach to out-of-air ascents. *SPUMS J* 1993; 23 (4): 195-8
- 19 Gorman D and Richardson D The SPUMS Workshop on Emergency Ascent Training. *SPUMS J* 1993; 23(4): 236-238

THE CASE FOR DIVING DIABETICS

Phil Bryson, Chris Edge , David Lindsay and Peter Wilmshurst

Up until the mid 1970s, the British Sub-Aqua Club (BS-AC) allowed diabetic divers to dive provided they were well-controlled and had not had an attack of hypoglycaemia within the past year. However, in 1975 a diabetic diver was diving on a wreck off the south-west coast of England called the *Persier*. This cold water wreck is at a

depth of about 28 m. The diver had ascended normally, well within the no-stop time according to the BS-AC/RNPL 1972 tables, and had signalled "OK" to his buddy on the surface. On swimming back to the boat, he was noted to be having some difficulties and had to be dragged on board the boat, where he collapsed. His problems were ascribed initially to diabetes and not to decompression illness. He was therefore not recompressed for some hours. Unfortunately, even after the symptoms of decompression illness were recognised and treated, he was left with permanent paraplegia from a level of approximately T10 down. He later committed suicide as a result of his confinement to a wheelchair. The ban on diving by diabetics was introduced by the BS-AC as a direct result of this accident.

This diabetic diver suffered from sudden onset decompression illness. There was no evidence that his diabetic condition had caused this. A post-mortem showed the presence of a patent foramen ovale (PFO)¹ which may or may not have contributed to this particular incident. Further, it was known from an unpublished survey carried out by Eno that several diabetic divers had continued to dive despite the ban on diabetics and that none of these divers had suffered from an increased incidence of decompression illness or, more importantly, suffered from hypoglycaemic attacks whilst diving.

Given this data, three of us (Edge, Lindsay and Wilmshurst) came to the conclusion that there was no reason, given the current state of knowledge and medical technology, for prohibiting diabetics from diving with the BS-AC, *provided certain strict medical criteria were met by the potential diving diabetic.*² Independently, Bryson had come to the same conclusions on behalf of the Sub-Aqua Association (SAA).

To be allowed to dive, the diabetic must not only satisfy medical criteria, but he or she must take additional precautions when diving, both to ensure the well-being of him/herself and also the well-being of the diving buddy and the rest of the party of divers. These conditions are set out below:

Medical conditions

Stated briefly, the diver should not have any of the long-term complications of diabetes. The medical conditions apply to both insulin dependent and non-insulin dependent diabetics. Although hypoglycaemia is a relatively uncommon in non-insulin dependent diabetics the risks are not negligible and any potential diver should be using a short-acting anti-diabetic drug, if such medication is necessary.

However it does appear that non-insulin dependent diabetics can generally exercise without fear of a deleterious metabolic response.³ The BS-AC issues forms for the

diabetic and his/her diabetologist to complete which ask if any of the following statements are true:

1. Has the diabetic's medication regime altered within the last year?
2. Have any episodes of hypoglycaemia occurred within the last year and if so, under what circumstances did these occur?
3. Has the diabetic been hospitalised within the last year for any condition related to diabetes?
4. Has the diabetic's level of control been in any way unsatisfactory throughout the last year?
5. Is microalbuminuria present?
6. Is there any degree of retinopathy present?
7. Is there any degree of neuropathy (sensory, motor or autonomic) present?
8. Is there any evidence of vascular or micro-vascular disease present and, if so, where?

In addition, the form asks the diabetologist to say whether in his/her opinion, the diabetic is in any way mentally or physically unfit to undertake scuba diving, a recreation that involves a degree of stress and exertion. If the answer to any of these questions is "yes", then the diabetic would not normally be allowed to dive. An exception is usually made if the diabetic has only a mild background retinopathy. The diabetic must undergo a complete physical examination annually and be passed as fit to dive by a physician with a special interest in scuba diving after reviewing the answers to the questions posed above. Finally, a copy of the forms is sent to one of the authors (Edge) in order that a database can be built up on the diabetic divers for future use.

Diabetic diving standards

In general, we advise the diabetic to dive only once or twice per day and not to dive more than three days consecutively. This prevents the build-up of an excessive tissue nitrogen load. It is helpful to both the diabetic diver and to the other members of the diving club if the diabetic gives an annual lecture to the club on the problems of diabetes and diving, if necessary with practical illustrations of the administration of glucose and the measurement of blood glucose.

The dive itself can be divided into three stages, namely pre-dive, dive and post-dive. Each diabetic diver and their branch diving officer is given a sheet with the following guidelines for each of the three stages of the dive:

Pre-dive

The diving diabetic should be as fit and mentally prepared to dive as his or her non-diabetic buddy. They should preferably be wearing at all times an SOS (Medic

Alert) bracelet stating that the bearer is a diabetic and also a diver and that therefore the possibility of decompression illness must be considered should the diver be taken ill. The diabetic partner should be especially careful with regard to being adequately hydrated as there is some evidence that the level of hydration affects the chances of experiencing decompression sickness. The dive marshal should be aware that the subject is a diabetic and should also be informed of the profile of the dive (plan the dive and dive the plan). The diabetic diver's buddy should be a person who is either i) a regular diving partner and who is familiar with the diabetic and the problems he or she is likely to experience or ii) a trained medic or paramedic who is familiar with the problems of diabetics. Clearly, the buddy should *not* also be diabetic. The diabetic should carry with them on a dive a kit consisting of:

1. Oral glucose tablets.
2. Emergency intramuscular injection of glucagon.
3. Glucose oxidase sticks together with the necessary kit and instructions for the use of such kit.
4. Normal diver safety equipment with one or more of the following items: surface marker buoy, flag, personal flares, emergency beacon.

Diabetics should plan to carry glucose tablets or a tube of glucose paste with them in a small waterproof casing or bag *during the dive*. The diving buddy must know the whereabouts of these tablets or paste and be able to gain access to it in the event of an emergency. It is essential that there is at least one person in the dive party of the diabetic who is able to use and administer the glucose tablets and intramuscular injection of glucagon. Just prior to diving, it would seem sensible for the diabetic diver to ensure that he or she has a *slightly* higher than normal blood sugar level by consuming glucose in whatever form takes their preference (glucose tablets, barley sugar sweets etc.). Blood glucose should be measured using a glucometer at this time.

Dive

A diabetic diver should not dive deeper than 30 metres until a considerable experience of diving and its associated problems has been gathered by the BS-AC/SAA medical committee. He or she should remain well within the tables or have more than 2 minutes no-stop time left on a dive computer.

Post-dive

On arrival back at the boat (or on shore if a shore-dive) the diabetic must check his glucose level and, if necessary, correct it in the appropriate manner. Any adverse symptoms or signs should be reported immediately either to the diving buddy or to the dive marshal and should

not be passed off as merely "part of diving".

The instructions to the diabetic diver and the diving officer are at pains to emphasise that the symptoms of low blood sugar may mimic those of neurological decompression sickness or a gas embolism and vice-versa, e.g. confusion, unconsciousness, fits. In this situation, first aid therapy must be given to the diabetic casualty as though both conditions were present i.e. 100% oxygen and treatment for low blood sugar. In the event of there being an incident in the water or on the boat, the diabetic diver should be brought to the boat or shore as soon as possible. The blood glucose should be measured using the equipment in the diabetic emergency kit if this can be swiftly performed. Oral glucose should be administered to the subject with low blood sugar if conscious; otherwise, an intramuscular injection of glucagon (1 mg) should be given. Medical attention and recompression facilities should be sought as soon as possible.

Experience to date

The BS-AC and SAA have admitted diabetics who fulfil the medical criteria set out above to dive since November 1991. During this time, more than fifty diabetics have registered with the BS-AC. Their ages range from 17 to 46 and are of both sexes in roughly equal numbers. Both insulin-dependent and non-insulin dependent diabetics are registered. Some of the diabetics who contact us wishing to dive state that they will be diving to a depth of no more than 15 metres and will be diving in warm tropical waters but the majority are diving in British waters. Currently, there are three National Instructors (the highest teaching grade) within the BS-AC who are registered diabetic. Thus far (October 1993) there have been no reported incidents involving diabetics or their diving buddies. We hope that the standards set out above are such that this will remain the situation, but the situation is kept under constant review.

References

- 1 Wilmshurst PT, Byrne JC and Webb-Peploe MM. Relation between interatrial shunts and decompression sickness in divers. *Lancet* 1989; ii: 1302-1306
- 2 Edge CJ, Lindsey D and Wilmshurst PT. Diabetes and diving. *Diver* 1992; 37 (Feb): 35-36
- 3 Wasserman DH and Abumrad NN. Physiological bases for the treatment of the physically active individual with diabetes. *Sports Med* 1989; 7: 376-392

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SINUS BAROTRAUMA

A BIGGER PICTURE

Carl Edmonds

Abstract

The major English language publications on sinus barotrauma are reviewed, and a new clinical series of 50 cases is compared with a previous survey. The various symptomatologies, complications, investigations and treatments are discussed in relation to these series.

Background

Fifty years ago sinus barotrauma from aviation exposure was well described by Campbell^{1,2}. The injury was due to the changes in volume of the gas within the paranasal sinuses during ascent or descent, when those changes could not be compensated by the passage of air between the sinus and the nasopharynx. It was the clinical manifestation of Boyle's Law, as it affected the sinuses.

The pathological changes found within the sinuses due to these aviation exposures included: Mucosal detachment; submucosal haematoma; blood clots in membranous sacs; small haemorrhages within the mucosa; and swelling of the mucous membrane (especially in the absence of previous sinusitis).

Weissman et al.³ described a series of 15 cases of frontal sinus barotrauma in aviators. Most were Grade III. They used a grading system as follows:-
Grade I A transient discomfort which cleared promptly and had only a slight oedema but no X-ray changes.