

Guidelines to Diabetes & Recreational Diving

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A workshop addressing issues of diabetes and recreational diving was jointly sponsored by the Undersea and Hyperbaric Medical Society (UHMS) and Divers Alert Network (DAN) to bring together experts and interested parties from within and beyond the international diving community. The meeting was held on June 19, 2005 in Las Vegas, Nevada, USA, following the UHMS annual scientific meeting. The objectives of the workshop were to review the existing data and, as warranted by participant support, to develop consensus guidelines to address diabetes and recreational diving. More than 50 individuals from seven nations, mostly clinicians and researchers, participated in the discussions.

Limitations: 1) The discussion was restricted to recreational diving. The issues concerning professional diving require future, separate deliberations. 2) This is a set of guidelines, not rules. The participants agreed that appropriate and justifiable differences in acceptable procedures may exist and that interest groups must have the flexibility to use the guidelines as they best serve their community's needs.

The guidelines were divided into three sections: 1) selection and surveillance of people with diabetes in scuba diving; 2) scope of diving by people with diabetes; and 3) glucose management on the day of diving. Individual divers must bear responsibility for their health and safety and for adherence to established guidelines developed to improve their protection and that of their dive partners. Divers with diabetes are encouraged to participate in relevant research studies to expand the data available concerning diving with diabetes. Anyone with questions should consult with physicians knowledgeable in both diving medicine and diabetes care.

Section 1. Selection and Surveillance

Those evaluating persons with diabetes for medical fitness to dive must first ensure that no other exclusionary conditions (*e.g., epilepsy, pulmonary disease*) exist. The physiological demands of

Diving must then be considered. Coronary artery disease is a leading cause of death in the largely non-diabetic diving population. Immersion may result in increased myocardial wall stress. There may also be a reduced awareness of ischemic symptoms. People with diabetes are at higher risk of medical complications such as myocardial infarction, angina and hypoglycemia than the general diving population. Such risks are exacerbated by the fact that many dive sites are quite isolated from medical aid. While only some medications increase the risk of hypoglycemia, all persons with diabetes are at risk of secondary complications of the disease.

Recreational scuba diving may be undertaken by candidates otherwise qualified to dive who use medication (*oral hypoglycemic agents [OHAs] or insulin*) to treat diabetes provided the following criteria are met.

- 1.1. Age 18 years and over (limit may be lowered to 16 years if special training* is available)
*special training will include dive training programs designed specifically to meet the education needs of individuals with diabetes and, desirably, to include participation by parents and/or responsible family members or guardians.
- 1.2. For a new diver at least three months have passed since the initiation or alteration of treatment* with OHAs or one year since the initiation of treatment with insulin. An established diver using OHAs who is started on insulin should wait at least six months before resuming diving.
**"alteration of treatment" is defined as a change in medication(s) or dosage(s) that could result in significant deviations from current status (changes likely to include only moderate change from current status would be described as "adjustment of treatment").
- 1.3. There should have been no episodes of hypoglycemia or hyperglycemia requiring intervention from a third party for at least one year, and no history of hypoglycemia unawareness. Note: certain OHAs (*e.g., metformin, acarbose*), when used on their own, do not predispose to hypoglycemia.
- 1.4. Glycosylated hemoglobin (HbA_{1c} - a measure of plasma glucose stability over the past two to three months) should be <9% when measured no more than one month prior to initial assessment and at each annual review. If HbA_{1c} >9% the diver should contact his/her diabetes specialist for further evaluation and modification of therapy.
- 1.5. There should be no: retinopathy worse than nonproliferative; significant autonomic or peripheral neuropathy; nephropathy causing proteinuria; coronary artery disease or significant peripheral vascular disease. Patients with retinopathy, peripheral vascular disease and/or neuropathy have a higher risk of sudden death due to coronary artery disease. Retinal hemorrhage could be precipitated by small changes in mask pressure during descent and ascent or equalizing maneuvers. Patients with neuropathy may experience exaggerated hypotension when exiting the water. Peripheral vascular disease may alter inert gas washout and predispose an individual to limb decompression sickness.
- 1.6. No more than two months prior to the first diving medical assessment and at each annual evaluation, a review is conducted by the candidate's primary care physician (knowledgeable in treating diabetes) who must confirm that: criteria 1.3 - 1.6 are fulfilled; the candidate demonstrates accurate use of a personal blood glucose monitoring device; and that the candidate has a good understanding of the relationship between diet, exercise, stress, temperature, and blood glucose levels.
- 1.7. No more than two months prior to commencing diving for the first time and at each annual review, a diving medical examination is completed, preferably by (*or in consultation with*) a doctor who has completed an accredited post-graduate diving medical examiner's course*. The review report completed by the primary care physician must be available. It is strongly recommended that formal evaluation for silent ischemia be undertaken for candidates over 40 years in accordance with U.S. American Heart Association/American College of Cardiology or equivalent guidelines.

**Any accredited course (one certified as fulfilling certain standards by a national and/or regional professional association) in diving medicine is acceptable.*

- 1.8. At the diving medical examination, the candidate acknowledges in writing the receipt of and intention to use the diabetic diving protocol; the need to seek further guidance if there is any material that is incompletely understood; and the need to cease diving and seek review if there are any adverse events associated with diving suspected to be related to diabetes.
- 1.9. Steps 1.1-1.8 must be completed annually, using the same physicians where possible. After the initial evaluation, periodic surveillance for silent ischemia can be in accordance with accepted guidelines for evaluation of diabetics.

Section 2. Scope of Diving

Persons with diabetes selected according to Section 1 of this document who satisfactorily complete a recognized diver-training course are considered suitable for recreational diving. The following stipulations and strong recommendations regarding diving activity and methods apply.

- 2.1 It is recommended that dives do not involve depths greater than 30 meters of sea water (100 fsw), durations longer than one hour, compulsory decompression stops, or take place in overhead environments. The depth limit is to avoid situations in which narcosis could be confused with hypoglycemia. The time limit is to moderate the time blood glucose would remain unmonitored. The decompression and overhead environment limits are to avoid situations in which direct and immediate access to the surface is not available.
- 2.2. Divers with diabetes should dive with a buddy/leader who is informed of their condition and is aware of the appropriate response in the event of a hypoglycemic episode. It is recommended the buddy does not have diabetes.
- 2.3. It is recommended that divers with diabetes avoid combinations of circumstances that might be provocative for hypoglycemic episodes such as prolonged cold and arduous dives.

Section 3. Glucose Management on the Day of Diving

Divers with diabetes who are selected according to Section 1 of this document, and who participate in appropriate diving activity as specified in Section 2, should use a protocol to manage their health on the day of diving. Note: the blood glucose monitoring protocols are applicable to people with diabetes whose medication may put them at risk of hypoglycemia.

- 3.1. For every day on which diving is contemplated, the diver should assess him or herself in a general sense. If he or she is uncomfortable, unduly anxious, unwell in any way (including seasickness), or blood glucose control is not in its normal stable pattern, DIVING SHOULD NOT BE UNDERTAKEN.

- 3.2. The suggested goal for the diabetic approaching any dive is to establish a blood glucose level of at least $150 \text{ mg}\cdot\text{dL}^{-1}$ ($8.3 \text{ mmol}\cdot\text{L}^{-1}$), and to ensure that this level is either stable or rising before entering the water. The workshop recommends that this be determined by three measurements of blood glucose, ideally taken 60 minutes, 30 minutes and immediately prior to diving. Diving should be postponed if blood glucose is $<150 \text{ mg}\cdot\text{dL}^{-1}$ ($8.3 \text{ mmol}\cdot\text{L}^{-1}$), or there is a fall between any two measurements.
 - a. Where relevant, strategic and individually tailored reductions in dosages of OHA medication or insulin on the evening prior or on the day of diving may assist in meeting these goals. Initial testing of individual protocols should be conducted under very controlled circumstances.
 - b. Where relevant, a regimen of incremental glucose intake to correct inappropriate pre-dive levels or trends may assist in meeting these goals.
- 3.3. It is recommended that diving should be postponed or cancelled if blood glucose levels are higher than $300 \text{ mg}\cdot\text{dL}^{-1}$ ($16.7 \text{ mmol}\cdot\text{L}^{-1}$).
- 3.4. Divers with diabetes should carry oral glucose in a readily accessible and ingestible form at the surface and during all dives. It is strongly recommended that parenteral glucagon is available at the surface. The dive buddy or other person at the surface should be knowledgeable in the use of glucagon. If symptoms or indications of hypoglycemia are noticed underwater, the diver should surface, establish positive buoyancy, ingest glucose and leave the water. An informed buddy should be in a position to assist throughout this process. Use of an "L" signal with the thumb and index finger of either hand is recommended as a signal for suspected hypoglycemia.
- 3.5. Blood glucose levels should be checked at the end of every dive. Appropriate response to the measured level can be determined by the individual mindful of his or her plans for the rest of the day. It should be noted that the requirements for blood glucose status outlined in 3.2 remain the same for any subsequent dive. In view of the recognized potential for late decrements in blood glucose levels following diving it is strongly recommended that the level is checked frequently for 12-15 hours after diving.
- 3.6. Divers with diabetes are strongly recommended to pay particular attention to adequate hydration on days of diving. Elevated blood glucose will lead to increased diuresis. While the data are limited, there is some evidence from divers with diabetes that an increase in hematocrit observed post-dive (*suggesting dehydration*) can be avoided by deliberate ingestion of fluid.
- 3.7. Divers with diabetes should log all dives, associated diabetic interventions and results of all blood glucose level tests conducted in association with diving. This log can be used to refine future planning in relation to diving.