

# The world as it is

## Swedish recommendations on recreational diving and diabetes mellitus

Johan Jendle, Peter Adolfsson and Hans Örnhagen

### Abstract

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Divers from many countries travel to explore various diving sites worldwide. In 2005, the Divers Alert Network (DAN) wrote guidelines for recreational diving and diabetes mellitus, but there is no up-to-date consensus or adoption of international guidelines on diabetes and diving. There are also large differences between the regulations in different countries. This is potentially both a medical and an insurance problem for a diver with diabetes. We present the current Swedish recommendations for recreational divers with Type 1 diabetes mellitus.

### Key words

Diabetes, recreational diving, fitness to dive, safety, safety memorandum, disability

### Introduction

In Sweden, recreational scuba diving has been permitted since 1998 for individuals with type 1 diabetes mellitus (DM1) under certain conditions. According to the Swedish Hyperbaric Medical Society's policy on diabetes mellitus from 1998, recently revised in 2011, it is possible for well-controlled and well-informed individuals with DM1, or people with type 2 diabetes (DM2), on either insulin or combinations of oral hypoglycaemic agents (OHAs) to be accepted for recreational diving.<sup>1</sup>

An important part of the acceptance of these recommendations is a consensus between the responsible specialist in diabetology, the diving physician and the diver. The following aspects need to be met:

- Acceptable glycaemic control HbA1c 52–73 mmol mol<sup>-1</sup> (5–8.8% National Glycohemoglobin Standardization Program), without any long-term diabetic complications. Mild diabetic retinopathy is accepted.
- No episode of severe hypoglycaemia should occur during the last year and no report of hypoglycaemic unawareness.
- The diver should have good knowledge of how to manage their diabetes, and how to adjust insulin doses and the amount of carbohydrates prior to physical activity.
- Regular self-monitoring of blood glucose (SMBG) should be done at least 4–6 times daily during the days of diving and the week prior to diving.
- Continuous glucose monitoring (CGM) should be performed on an annual basis.

The risk for an individual with diabetes during diving is

linked to the risk of hypoglycaemia while in water. The symptoms of hypoglycaemia could mimic those seen from other conditions during a dive, e.g., fatigue, shivering and reduced cognitive function due to hypothermia. Moreover, in case of decompression illness, the picture becomes even more difficult.<sup>2</sup> It is easy to misjudge the symptoms and this could lead to unnecessary air transportation and recompression treatment when the correct treatment would instead be to add carbohydrates or administer glucagon. An untreated hypoglycaemic episode during the dive might increase the risk for the person with diabetes as well as the diving buddy. Severe hypoglycaemia during diving could lead to drowning. Taking into account the facts above, it is important to minimize the risk of hypoglycaemia when allowing people with diabetes to dive. The most important advice is to prevent hypoglycaemia. It is also important to know how to treat low glucose levels during a dive since a rapid ascent is not always possible.

### Preventing hypoglycaemia

Hypoglycaemia is defined as a plasma glucose level below 4 mmol L<sup>-1</sup>.<sup>3</sup> The prevalence of hypoglycaemia during diving can be reduced by systematic measurement of glucose levels using home glucometers.<sup>4</sup> Prior to diving the glucose levels should be checked more frequently. Strive for a stable glucose level to minimize hypoglycaemic events and to reduce the number of hyperglycaemic events the week before diving. Pronounced and repeated hypoglycaemic events have been shown to have an impact on the hormonal counter regulation, reducing the elevation of glucagon, cortisol, growth hormone, adrenaline and noradrenaline.<sup>5</sup> Thus the hormonal response to a hypoglycaemic event during diving or to the physical activity itself might be impaired. Structured frequent glucose monitoring shows the level of

glucose and gives a rough overview of the trend. A declining trend of glucose the hour prior to the dive indicates a higher risk of hypoglycaemia during the dive and the dive should then be postponed. In order to modify the glucose trend at a slightly earlier stage, giving a more stable or increasing glucose value, the diver could add carbohydrates. The last measurement, 10 min before the dive, shall always be at the same level or higher than the previous (30 min before Dive 1).

The recommended structured glucose monitoring series in association with diving includes measurement of plasma glucose 60, 30 and 10 min prior to diving. This visualises the glucose trend. Aim for a stable glucose level between 7–12 mmol L<sup>-1</sup> 10 min prior to the dive and avoid a falling trend. Assess plasma glucose immediately post dive. This visualises the glucose trend during diving.

The timing of meals is very important. A meal should take place 1.5 to 2 hours prior to all dives. With this approach the insulin levels will be decreasing when the dive starts and this will lower the risk of hypoglycaemia during the dive. The insulin dose prior to a meal sometimes needs to be reduced aiming at a stable glucose level of 7–12 mmol L<sup>-1</sup> prior to diving. The intake of additional carbohydrates, 15–20 g per 70 kg body weight, just before diving further increases the safety.

Field studies, have shown that glucose levels in divers with DM1 decrease by about 1.7 mmol L<sup>-1</sup> during a 60-min dive to 18 metres' depth.<sup>6–8</sup> All dives should be logged in a personal logbook with data on carbohydrate intake, insulin dose, and glucose levels prior to and after the dive, together with information about the type of dive (depth, duration, level of physical work, etc). This log can be used later to refine future planning in relation to diving.

**Figure 1**

The L-signal, where the index finger and thumb forms the letter L is used to call the attention of the diabetic diver's buddy when the diver experiences symptoms of possible hypoglycaemia



### Hypoglycaemia – how to inform your buddy

It is very important to practise signalling of hypoglycaemia. The 'L-signal', with the index finger and thumb forming the letter L is used to alert the diving buddy (Figure 1). If the signal is given, the diver, with their instructor and/or diving buddy, should start ascending to the surface. Depending on the depth and length of the dive, the decision will be to go to either a safety stop or the surface. The individual with diabetes should ingest carbohydrates (as carbohydrate gel or glucose/fructose solution) before even starting the ascent. These formulations should always be kept in pockets of the BCD during all dives. We recommend that both the diver with diabetes and their diving buddy carry carbohydrate gel or glucose/fructose solution in their BCD. Divers with diabetes should practise ingesting gels underwater in controlled conditions. Following an underwater hypoglycaemic event treated with ingestion of carbohydrates, the dive should always be aborted following normal decompression routines.

### Insulin pumps – how to manage during diving

Individuals on subcutaneous insulin infusion pumps should remove the pump shortly before the start of the dive. There is a risk of malfunction or permanent damage of the pump if used during diving. Most insulin pumps on the market are water-resistant but are not approved for use at increased pressure. A reduction of the basal insulin dose (temporary basal reduction) is recommended 1–2 hours prior to diving. This lower amount of insulin before and during the dive reduces the risk of hypoglycaemia. The insulin pump should be reconnected as soon as possible post dive.

### Conclusions

We are aware that diving, even in the absence of diabetes, is a potentially dangerous activity with three to four fatalities in Sweden occurring every year. However, we feel convinced that if the recommendations given are followed, the diabetes as such will not contribute to fatalities during diving.

### Diving safety<sup>9,10</sup>

- Recommended maximum diving depth, is 20–25 metres allowing direct ascent.
- Diver with diabetes should dive with a buddy without diabetes.
- Diver with diabetes shall inform their divemaster/dive instructor/buddy about the limitations and special conditions that apply to diving with diabetes.

### Hypoglycaemia (glucose level < 4 mmol L<sup>-1</sup>)<sup>3</sup>

- If hypoglycaemia is suspected, the diver should be instructed to take glucose gel and be brought on board or ashore.
- Glucose level should be measured immediately diving is completed.
- If hypoglycaemia is confirmed, ingest carbohydrates

(20 g) to a fully awake individual.

- If unconscious, give an injection of 1 mg of glucagon (intramuscular).
- Call for emergency help.

#### Contra-indications to diving in DM divers<sup>9,10</sup>

- serious hypoglycaemic event during the last year;
- hypoglycaemic unawareness;
- repeated episodes of inpatient care;
- physical or psychological conditions that might interfere with diving;
- known diabetic complication except mild diabetic retinopathy.

#### For further background information, the following websites are recommended:

<[www.diversalertnetwork.org](http://www.diversalertnetwork.org)>  
 <[www.ukdiving.co.uk](http://www.ukdiving.co.uk)>  
 <[www.spums.org.au](http://www.spums.org.au)>

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Johan Jendle, MD, PhD<sup>1,2</sup>, Peter Adolfsson, MD<sup>3</sup>, Hans Örnham, MD, PhD<sup>4</sup>

<sup>1</sup>Endocrine and Diabetes Center, Karlstad Hospital, Karlstad, Sweden.  
<sup>2</sup>School of Health and Medical Sciences, Örebro University, Sweden.

<sup>3</sup>Göteborg Pediatric Growth Research Center, Department of Pediatrics, Institute of Clinical Sciences, Sahlgrenska Academy at University of Gothenburg, Göteborg, Sweden.

<sup>4</sup>Swedish Sports Diving Federation, Farsta, Sweden.

#### Address for correspondence:

Johan Jendle

Endocrine and Diabetes Centre, Karlstad Hospital, SE-65185 Karlstad, Sweden

**Phone:** +46-(0)54-616448

**Fax:** +46-(0)54-617069

**E-mail:** <[johan.jendle@liv.se](mailto:johan.jendle@liv.se)>