Influence of glycemic control on sleep in type 1 diabetic patients

Internship offer

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Context: Type 1 diabetes is an increasingly common autoimmune disease, whose incidence in children is rising by approximately 4% a year in France. It is characterized by the absence of insulin, the hormone that enables the body to store sugar. This absence means a major risk of hyperglycemia when eating [4].

Treatment of type 1 diabetes relies on subcutaneous injections of insulin, several times a day, to compensate for the body's failure to produce insulin. Insulin pumps are useful for some patients: the size of a cell phone and attached to a belt, they inject insulin directly via a catheter. The pump is programmed to deliver a continuous quantity of insulin (basal rate), followed by boluses at mealtimes (quantity of insulin depending on carbohydrates consumed). It can also adapt insulin doses to the duration and choice of activity [1]. Recently, closed-loop hybrid systems have been developed. The operating principle is illustrated in Figure 1. Combining an insulin pump, a continuous glucose meter and an algorithm, they use artificial technology to mimic the way the human pancreas naturally regulates blood glucose, automatically adjusting insulin delivery to help manage blood sugar levels [3].

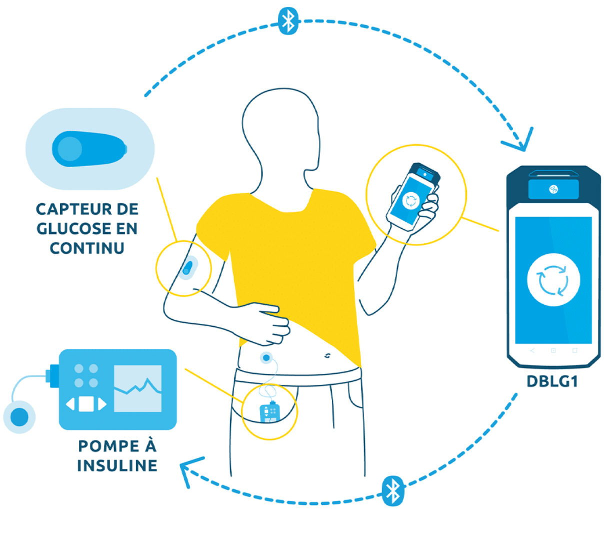

Figure 1: Schematic diagram illustrating the hybrid closed-loop blood glucose control system [2].

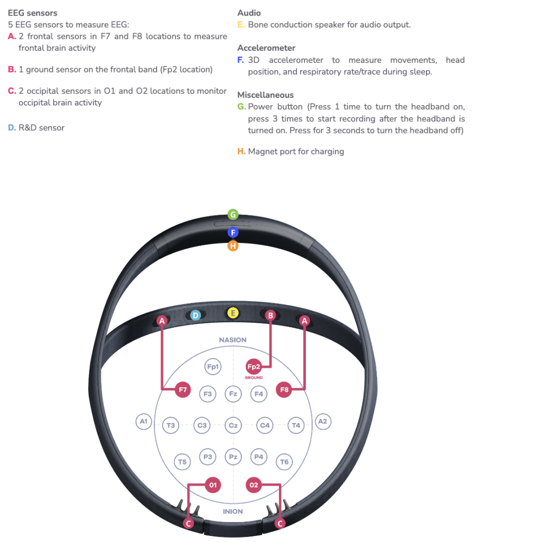

Figure 2: Dreem 3 recording headband, with electrode location [5].

Goal: The internship will be carried out in collaboration with the team led by Professor Thivolet, a diabetologist at Hospices Civils de Lyon, in charge of setting up the protocol and medical follow-up.

The aim will be to assess whether optimizing glycemic control after one month's use of a hybrid closed-loop system improves measured sleep efficiency. Measurements will be taken over 3 to 5 nights, compared with a control period of identical duration before switching to the hybrid closed-loop system. For this, we will have access to two types of measurements.

- Blood glucose data can be used to track variations in a patient's blood glucose levels over the course of the night.
- Sleep data are generated by a Dreem 3 recording headband. Placed around the patient's head at night, it measures the brain's electrical activity using electrodes to determine sleep phases (wakefulness, REM sleep, slow wave sleep, deep sleep, etc.). This device is shown in Figure 2.

During the internship, we will have to devise relevant measures to quantify sleep quality and the effects of glycemic control on sleep.

1. *Sleep quality.* We could ask, for example, if the sleep cycle was broken during the night, or if there were any awakenings. Once we've come up with a relevant indicator, we'll be able to compare the quality of each patient's nights before and after switching to the hybrid closed-loop system.
2. *Effects of glycemic control on sleep.* We will then ask whether a night interrupted by awakenings can be explained by sudden variations in blood sugar levels. Several measures to answer this question will be proposed and compared. During the course, we'll start by using the simplest measures of blood glucose-sleep correlation (e.g. correlation conditional on sleep phase). More complex measures can then be constructed. For example, an event correlation measure (blood glucose peaks and waking/sleep cycle break) could be implemented.

References

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