nano-tera.ch
swiss scientific initiative in health / security / environment systems

D1NAMO NTF

FNSNF

D1NAMO: Diabetes type 1 Non-invasive Activity MOnitoring

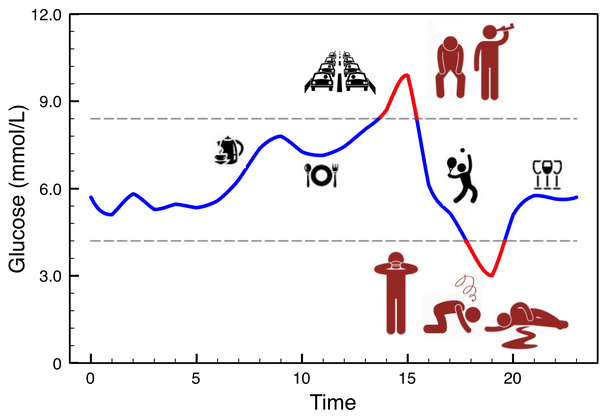
Fabien Dubosson, Jean-Eudes Ranvier, Stefano Bromuri, Jean Paul Calbimonte, Michael Schumacher, Juan Ruiz, Karl Aberer

HES-SO VS, EPFL, HRC

Problematic

Diabetes type 1 is an autoimmune disease that affects the insulin level of a patient.

Once a patient is affected by diabetes type 1, the only possible treatment is insulin shots several time a day to keep the insulin level under control and keep the risk of hypoglycaemia low. Unfortunately, intensively controlled glycaemia levels allows patients to have a better outcome from the perspective of microvascular and macrovascular complications of diabetes type 1, meaning that there exist a trade-off between limiting the amounts of hypoglycaemias of the patient and limiting the occurrence of cardiovascular diseases later in the patient life.

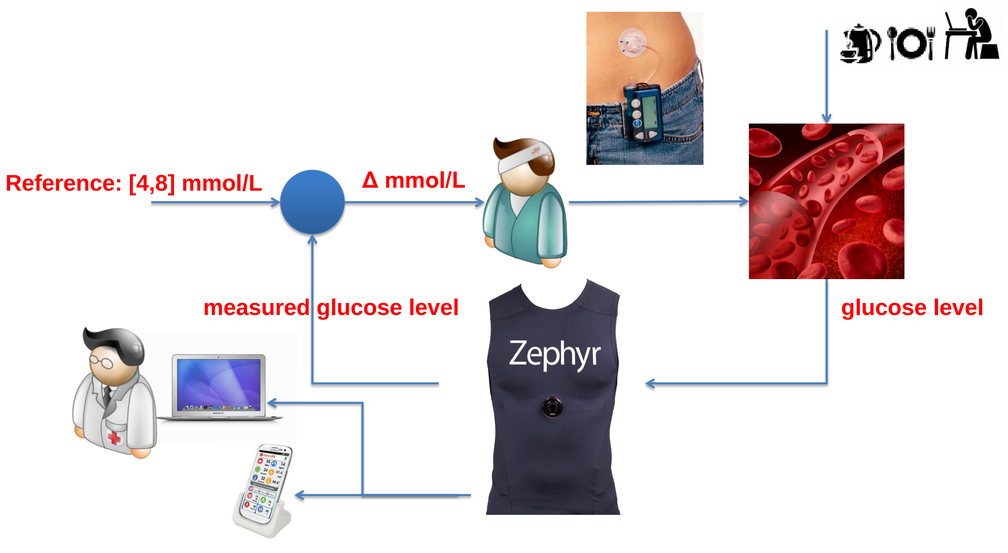


Consequently, understanding the physiological counter-regulatory responses caused by hypoglycaemia with respect to the usage of insulin would allow to improve the management of hypoglycaemic episodes. Also observing the physiological values of patient before, during and after occurrences of hypoglycaemia would permit to have a better understanding of the phenomenon as well as to allow a non-invasive prediction of hypoglycaemic episodes. Furthermore, being able to predict hypoglycaemia given the level of activity of the patient during the day and the week would allow doctors to act pre-emptively toward the hypoglycaemias.

Proposed solution

The D1NAMO project aims to develop a pervasive personal-sensing application for patients with diabetes type 1 that will make use of advanced wearable devices to monitor the physiological data of the patient such as heart rate, ECG and breathing rate. This would allow to:

- Monitor the activity of the patient.
- Provide informative feedback to the patient and the doctor about the physical activities performed and their impact on diet and medication.
- Detecting symptoms of hypoglycaemic attacks in order to provide early alerts to the doctors.



Current approach

- Hypothesis: Hyper- and Hypo- glycaemia can be detected from non-intrusive physiological signals like ECG:

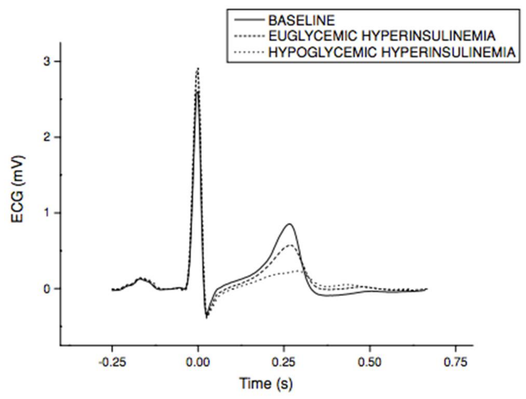
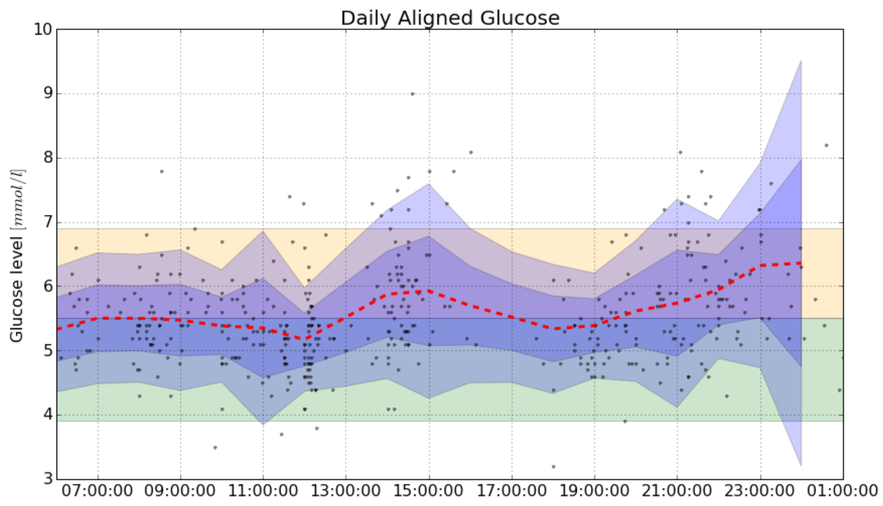
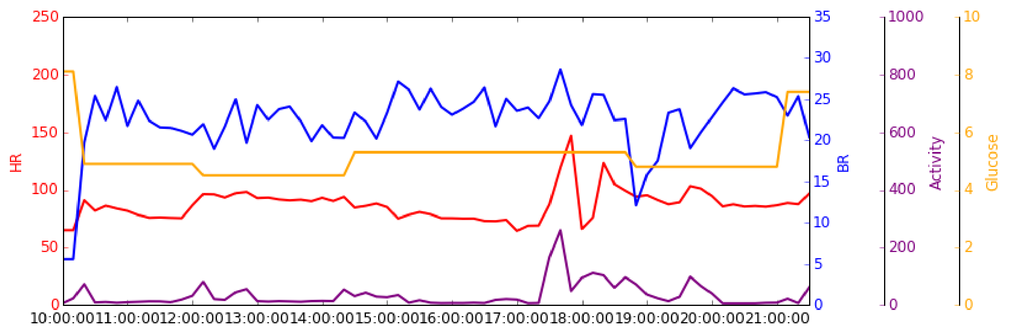


Figure 1. A representative case showing a slight amplification of the R wave, a decrease in the ST segment, a remarkable flattening of the T wave, and a slight prolongation of the QT interval as characteristic electrocardiographic changes in response to euglycemic and hypoglycemic hyperinsulinemia.

- A dataset composed of glucose values in relation with their related physiological signals are acquired in order to build glucose models:



- The signals associated with glucose are coming from three main sensors: ECG, Breathing and Accelerometers:



- The built models will permit to construct a platform helping patients and medical doctors to monitor the disease: