Future Treatments for Type 1 Diabetes Mellitus with Emphasis on Technical Devices

Abstract

Sweden has one of the highest percentages of patients with type 1 diabetes Mellitus (T1DM). Without a cure for the autoimmune disease, physicians can only provide treatment. Fluctuating blood glucose levels can result in serious complications, such as premature death. Treatment offered today lack individualisation and automatic insulin systems are not possible with today's technology. Monitors only considers glucose, but hormones, such as stress, can have an impact on blood glucose levels.

To improve treatment, a closed-loop system could be used to create an artificial pancreas, which automates monitoring of insulin and intake. Possible solutions are a dual-hormone pump, AI and applications that calculate carbohydrates. These methods could ease patients everyday life.

Results

Smart lenses could be used to monitor glucose levels and replace continous glucose monitoring (**CGM**) as it is today and to detect retinopathy. The smart lense could aid in detection of meals by analyzing footage and calculate the insulin needed simultaneously.

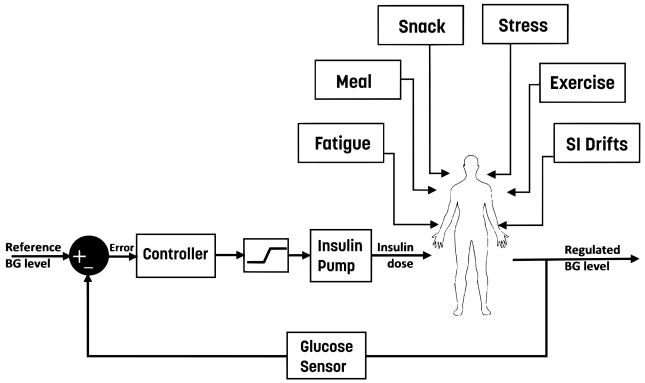
Nanorobots are an invasive method with potential to replace both monituring of glucose and distribute insulin. However nanorobots are far away from being implemented in vivo.

A **closed-loop system** refers to a system without human interaction. This would be an ideal solution for patients with T1DM. Today only hybrid closed-loop systems exist with a CGM linked to an pump that delivers insulin based on an algorithm adjusting basal insulin. Patients are required to interact with the system to some degree.

Diabits is an application which can calculate and learn the users insulin dosage. The machine learnig algorithm consider historical data, current CGM data, intake of carbohydrates and physical activity via a monitor from a smartwatch.

30 minute prediction	**60 minute prediction**
87% clincally accurate	70.6 % clinically accurate
99.6 % clincally acceptable	97.5 % clinically acceptable

To control glucose levels, a model based on a control technique was tested in a Hardware-in-the-loop simulation. The simulation show results of stimuli in real time. In the figure below one can se all the parameters taken into consideration. They were chosen due to their effect on blood glucose levels. When compared to in-silico simulation it was considered successfull and did not exceed 5.6 mmol/L which is within the optimal levels between 3.5 - 7.6 mmol/L.



There are several problems that researchers encounter when trying to invent userfriendly treatment methods for diabetes. It is a high-maintenance disease that requires detailed planning of everyday life, to calculate insulin accordingly. This is time-consuming and demanding for patients.

Since diabetes requires personalized treatment, machine learning is a natural approach for diabetes treatment due to its ability to learn based on datasets. However, the AI algorithms are more accurate with a regular and habit based lifestyle as the algorithms are constantly learning.

Conclusion

- Researchers are successively approaching a fully closed-loop system with minimal human interaction. AI and dual-hormone pumps seem to be the most promising technological advances. This results in stabilizing glucose levels and offers less late-life complications and living conditions for patients living with type 1 diabetes.

- Smart lenses and nanorobots could be the future method to treat diabetes in a non-invasive way.

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