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Modeling the Impact of a Standardized Breakfast on T1DM Fasting Blood Glucose

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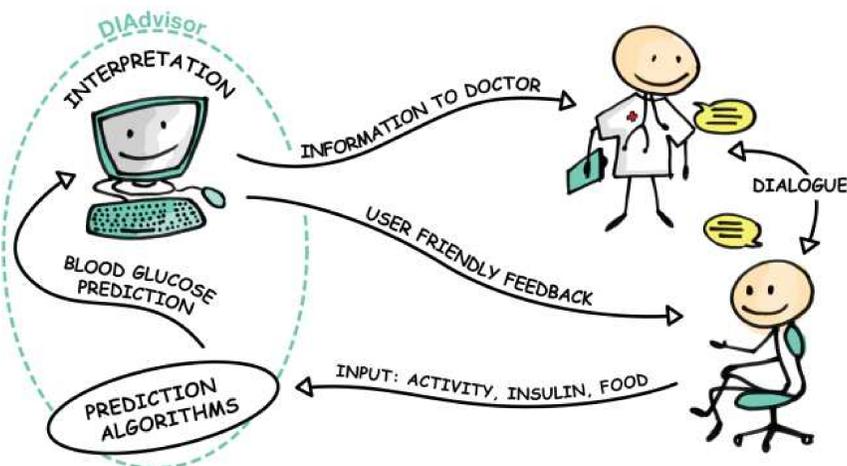
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Background

The focus of the European project DIAdvisor™ [3] is the development of a personalized tool providing diabetic patients with reliable and accurate near future blood glucose predictions in order to support the users in the insulin therapy decision-making tasks while letting them maintaining control over their own treatments management.



Results

Comparing the output of the model against the actual BG gave a FIT of 85.28 ± 7.21 . Simulating the models with the identified parameters in response to 10 [g] of glucose produced an increase in BG of 10.02 ± 9.72 [mg/dL] with peak time in the range 3 to 4 [h].

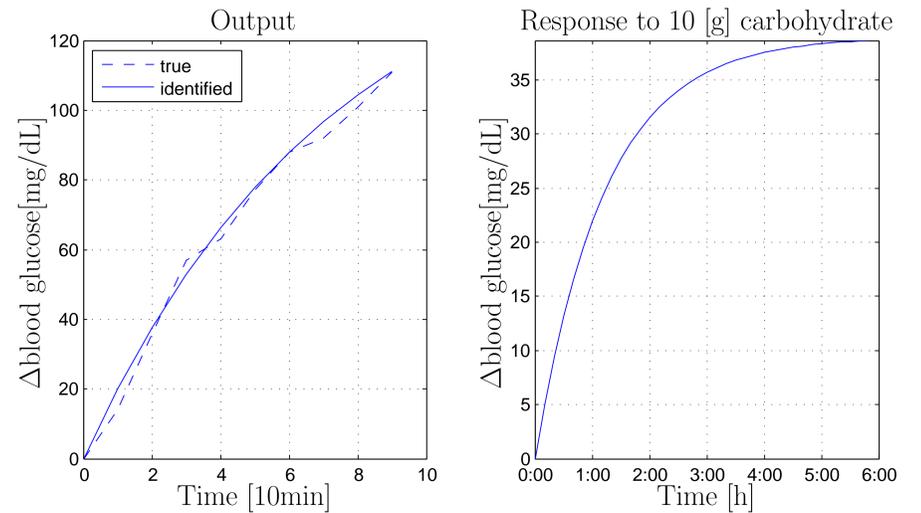


FIGURE 2: Patient 1. Results: *Left* actual interpolated blood glucose (dashed), estimated blood glucose (solid) [mg/dL]; *Right* Response to 10 [g] carbohydrate vs. Time [h]

Objective

The design of a controller for glycemia regulation, either in open as in DIAdvisor™ [3] or in closed-loop, relies on models able to describe the effects of a meal intake and an insulin injection on blood glucose dynamics. The purpose of this study was therefore to focus on the first mentioned and propose a physiological relevant yet parsimonious model for breakfast carbohydrate action on overnight fasting blood glucose in T1DM patients when no insulin is taken.

Data

5 T1DM subjects admitted at the clinical investigation center at 7:00 am fasting from the midnight were served a standardized breakfast containing 40 [g] carbohydrate at 8:00 am. The corresponding insulin bolus was administered at 10:00 am. The observation period for our purposes was 8:00-10:00 am during which blood samples were drawn every 10 minutes to assess glucose concentration utilizing a YSI 2300 STAT Plus blood glucose analyzer.

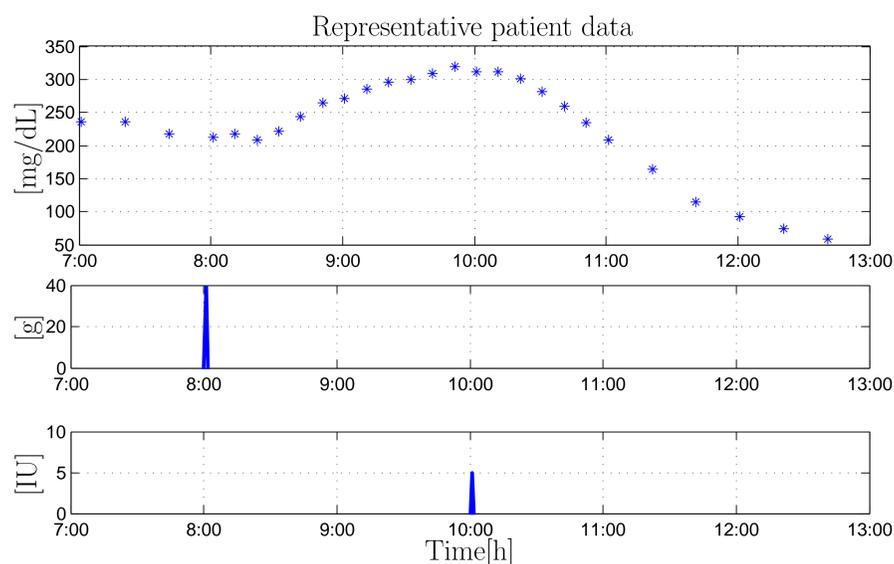


FIGURE 1: Patient 1. *Top* Blood glucose measured by the YSI [mg/dL]; *Center* Carbohydrate intake [g]; *Bottom* Insulin bolus [IU]. All the measurements vs. Time of the day [h]

Methods

Blood glucose data measured by the YSI were interpolated and uniformly resampled. Next, gain and time constant of the glucose peak for each of the subjects were estimated from data by means of system identification techniques.

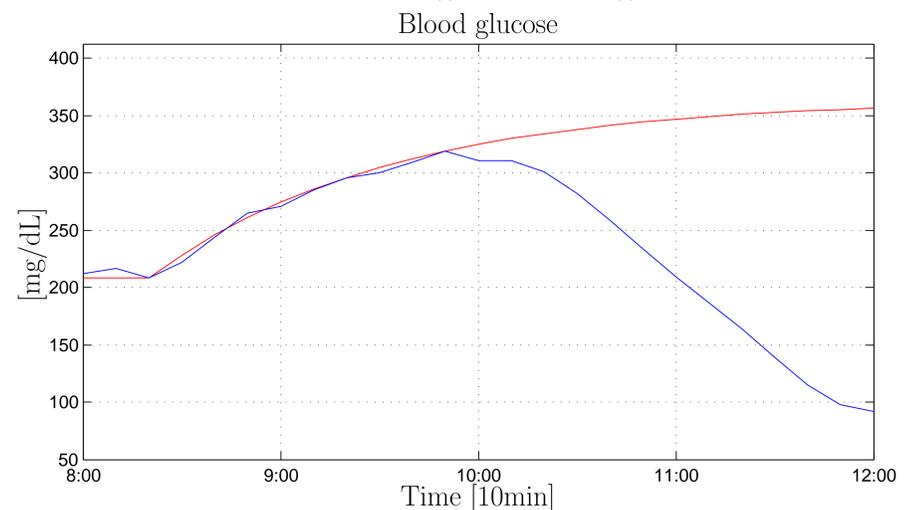


FIGURE 3: Patient 1. Carbohydrate response from model (red). Actual interpolated blood glucose concentration [mg/dL] vs. Time [10min]

Discussion

The numerous blood samples taken during the trial were exploited to the study purposes, making it possible to have a reliable continuous time signal representing glycemia in plasma. However, this is not common practice where BG samples are available a couple of times a day at best, or is assessed indirectly from CGMS measurements. The parameters in the model have physiological meaning, being related to the glucose tolerance of each individual and can be easily understood by practitioners.

Conclusions

Magnitude and duration of a blood glucose peak following a standardized breakfast not compensated by an insulin intake were estimated from T1DM patients data and can be used to describe meal impact in a controller design procedure either in open or in closed-loop.

Acknowledgments

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References

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