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TECHNOLOGY REPORT

# Model-Based Sensor-Augmented Pump Therapy

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## Abstract

***Background:***

In insulin pump therapy, optimization of bolus and basal insulin dose settings is a challenge. We introduce a new algorithm that provides individualized basal rates and new carbohydrate ratio and correction factor recommendations. The algorithm utilizes a mathematical model of blood glucose (BG) as a function of carbohydrate intake and delivered insulin, which includes individualized parameters derived from sensor BG and insulin delivery data downloaded from a patient's pump.

***Methods:***

A mathematical model of BG as a function of carbohydrate intake and delivered insulin was developed. The model includes fixed parameters and several individualized parameters derived from the subject's BG measurements and pump data. Performance of the new algorithm was assessed using $n = 4$ diabetic canine experiments over a 32 h duration. In addition, 10 *in silico* adults from the University of Virginia/Padova type 1 diabetes mellitus metabolic simulator were tested.

***Results:***

The percentage of time in glucose range 80–180 mg/dl was 86%, 85%, 61%, and 30% using model-based therapy and [78%, 100%] (brackets denote multiple experiments conducted under the same therapy and animal model), [75%, 67%], 47%, and 86% for the control experiments for dogs 1 to 4, respectively. The BG measurements obtained in the simulation using our individualized algorithm were in 61–231 mg/dl min–max envelope, whereas use of the simulator's default treatment resulted in BG measurements 90–210 mg/dl min–max envelope.

***Conclusions:***

The study results demonstrate the potential of this method, which could serve as a platform for improving, facilitating, and standardizing insulin pump therapy based on a single download of data.

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**Abbreviations:** (BG) blood glucose, (BW) body weight, (CF) correction factor, (CGM) continuous glucose monitoring, (FDA) Food and Drug Administration, (I:C) insulin-to-carbohydrate ratio, (MDI) multiple daily injection, (SAP) sensor-augmented pump, (TDI) total daily insulin, (UVa) University of Virginia

**Keywords:** insulin therapy, model-based insulin therapy, sensor-augmented pump

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