Medical Xpress

Model predicts blood glucose levels 30 minutes later

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A mathematical model created by Penn State researchers can predict with more than 90 percent accuracy the blood glucose levels of individuals with type 1 diabetes up to 30 minutes in advance of imminent changes in their levels—plenty of time to take preventative action.

"Many people with type 1 diabetes use continuous glucose monitors, which examine the fluid underneath the skin," said Peter Molenaar, Distinguished Professor of Human Development and Family Studies and of psychology. "But the glucose levels under the skin trail blood glucose levels from anywhere between 8 and 15 minutes. This is especially problematic during sleep. Patients may become hypoglycemic well before the glucose monitor alarm tells them they are hypoglycemic, and that could lead to death."

According to Molenaar, a person's blood glucose levels fluctuate in response to his or her insulin dose, meal intake, physical activity and emotional state. How great these fluctuations are depends on the individual.

"In the past decade, much progress has been made in the development of a mechanical 'artificial pancreas,' which would be a wearable or implantable automated insulin-delivery system consisting of a continuous glucose monitor, an insulin pump and a control algorithm closing the loop between glucose sensing and insulin delivery," he said. "But creating an artificial pancreas that delivers the right amount of insulin at the right times has been a challenge because it is difficult to create a control algorithm that can handle the variability among individuals. Our new model is able to capture this variability. It predicts the blood glucose levels of individuals based on insulin dose and meal intake."

The researchers created a time-varying model estimated by the extended Kalman filtering technique. This model accounts for time-varying changes in glucose kinetics due to insulin and meal intake.

The team tested the accuracy of its model using an FDA-approved UVa/Padova simulator with 30 virtual patients and five living patients with type 1 diabetes. The results appeared online this week in the *Journal of Diabetes Science and Technology*.

"We learned that the dynamic dependencies of blood glucose on insulin dose and meal intake vary substantially in time within each patient and between patients," said Qian Wang, professor of mechanical engineering. "The high prediction fidelity of our model over 30-minute intervals allows for the execution of optimal control of fast-acting insulin dose in real time because the initiation of insulin action has a delay of less than 30 minutes. Our approach outperforms standard approaches because all our model parameters are estimated in real time. Our model's configuration of recursive estimator and optimal controller will constitute an effective artificial pancreas."

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