Medical Xpress

Software program can predict blood sugar crashes, spikes for patients with type 1 diabetes

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Credit: Christina Ullman

The woman paced back and forth outside the airport, waiting anxiously for her husband to pick her up. She called him once, twice, three times. An hour later—at 7:00 p.m.—her phone finally rang.

"Where are you?" she demanded.

"It's only 6:00 a.m.," he mumbled. "I have plenty of time to pick you up."

As the woman had feared, her husband, who has type 1 diabetes, had spent the entire day in a kind of hypoglycemic—or low blood sugar—stupor.

This type of scenario is not uncommon among the world's 20 to 30 million people with type 1 diabetes, a disease in which the body does not produce insulin. These people must constantly monitor and control their blood glucose levels, adjusting their insulin with daily shots or an insulin pump to avoid crashes or spikes that, when severe, can be fatal.

Yet even the most sophisticated available glucose monitoring systems cannot adequately warn people that they are about to become hypoglycemic, especially while they are asleep, says Frank Schwartz, professor of endocrinology and J.O. Watson Chair for Diabetes Research at Ohio University. Those systems measure glucose levels in the fluid underneath the skin, which may be anywhere from 8 to 15 minutes behind actual levels.

"A patient who has hypoglycemia unawareness could already be unconscious before the sensor's hypoglycemia alarm tells them they are too low," he says.

Although these monitors collect nearly 300 data points per day on the patients who use them, analyzing all of that data to make treatment recommendations has become nearly impossible for physicians such as Schwartz, who manages some 400 to 500 patients.

A solution to the problem came to Schwartz from an unlikely place: his

oldest son Scott, a music producer.

"One day I was watching him merge 60 tracks of music into a single recording using a computer program called Pro Tools," he recalls. "I thought the music patterns resembled glucose patterns and that there must be a way to do this for diabetes. So I came knocking on the door of the computer scientists and found Cindy."

Cindy Marling, an associate professor of computer science, had a track record in building artificially intelligent software systems to help physicians manage data and follow trends in their patients' health. Schwartz, Marling, and Jay Shubrook, associate professor of family medicine, joined forces to build the 4 Diabetes Support System (4DSS), an experimental computer program that automatically merges and analyzes patient data and recommends personalized therapeutic adjustments for patients. The software could detect patient problems only after they occurred, however.

So the researchers approached Razvan Bunescu, a machine learning expert and associate professor of computer science, to create a revised version of the program that could warn people up to an hour in advance of imminent changes in their blood glucose levels, which would allow plenty of time for them to take preventative action.

With funding from the National Science Foundation, the team has created a software program that uses support vector regression, a time series forecasting technique previously used to predict stock market prices and utility loads. Specifically, the regression models are trained for each patient using current and past data about his or her blood glucose levels, insulin dosages, food intake, and exercise. The longer a person uses the program, the smarter it gets.

"The computer should be able to learn patterns from patient data and use

them to make predictions itself," Bunescu explains.

When the team first tested the software, it fared about as well as a physician in predicting glucose changes at 30 and 60 minutes. But after additional development of the technology, "we are now outperforming the experts," he reports.

"The neat thing about this software is that it has the ability to learn how individual patients respond to life events," Schwartz says. "So if, for example, you're ready to go to bed and you want to know whether you've had enough snack to keep your glucose from going low until morning, the program can run a simulation and tell you if you need more or less food."

In another example, if a user tells the system that he or she will go mountain biking "and you historically had become hypoglycemic two hours into your ride, the system would make a note of it," he says. "The next time you go riding the system would remind you to either eat plus reduce your basal insulin rate or stop your pump or whatever works best for you. In addition, it could alert you during the exercise if it determined that you were going to go too low in spite of the earlier suggestions. It could almost be a continuous mentor—or nag—giving safety reminders and helping with glucose control."

Another benefit of the software program, according to Marling, is that it will enable patients to play "What if?" games. Patients can ask, 'What if I have this chocolate sundae right now? What do I need to do to compensate?' The system can predict for them how their bodies will respond and recommend a dose of insulin.

Marling added that it's important to keep in mind that a computer is not licensed to practice medicine and that the FDA will not allow a computer it hasn't approved as a medical device to make therapeutic

interventions.

"We see this product making recommendations that an advanced practice nurse or other diabetes specialist would then have to approve," she says.

Now in its fourth clinical research study, the team has added a smart phone interface to make data logging even easier for patients. They hope this feature will help overcome one of the limitations of the program: human error.

"Some of the patients are very accurate (about logging data), but others forget what they ate," Bunescu says. "So data may be missing or the time when they ate may be wrong."

The researchers now are investigating the option of either licensing the software to a company or of creating their own company. Although they currently have some software ready to be commercialized, they plan to continue to improve it in the years to come.

"Diabetes is so complex, and the more we work on it, the more ideas we come up with," Marling says. "But we can't wait for the ultimate system; we have to use whatever we have now because it can really improve people's lives."

Schwartz is particularly excited about unveiling the software program.

"I've been taking care of patients for over 35 years and I have seen lots of bad things happen to patients with diabetes that theoretically are all preventable," he says. "If I could get this program into a useable form that could be used by patients throughout the world, I'd be pretty satisfied."

Provided by Ohio University