Moving towards an ‘artificial pancreas’ for people with diabetes

Living with diabetes often means having to prick your finger to test blood glucose levels several times a day.

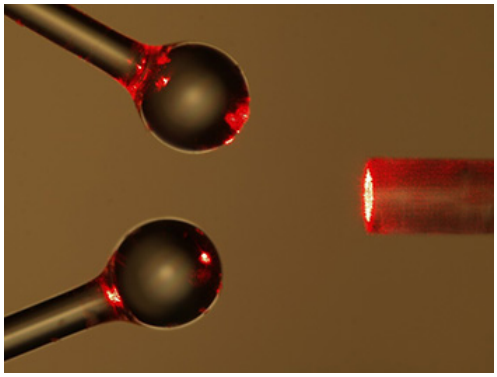
That’s why a group of researchers in Trondheim are working on creating an “artificial pancreas” to take over this responsibility. The work is still in its early stages, but the ultimate aim is for the device to automatically measure glucose levels, and administer insulin according to the results, doing away with regular manual testing.

“We would [measure] the glucose levels every few minutes, so almost continuously,” says Karolina Milenko, a research fellow at NTNU's Department of Electronic Systems and a member of the Artificial Pancreas Trondheim research group, who is working on developing a tiny, implantable blood-glucose sensor for the device. “Then we would have an insulin pump that would be connected with the sensor, allowing the pump to administer insulin accordingly.”

Some people with diabetes already have a pump that delivers a background level of insulin automatically, which they can top up manually when they need to. And some already use a device to measure blood glucose that sits just underneath their skin. These devices, which allow for either continuous or on-demand monitoring, measure the amount of glucose in the fluid that surrounds the body’s cells, and still need calibrating with a finger prick test occasionally.

But an artificial pancreas – which won’t resemble a real pancreas in appearance, but will mimic its role – could combine these two functions, measuring glucose levels continuously and releasing insulin as needed. This would help people with diabetes to keep their blood sugar levels stable, something which is important for both short and long-term health.

In a recent paper published in *Optics Letters*, Milenko and her colleagues detail a sensor that could one day measure blood glucose levels. It uses two optical fibres, each 220 microns in diameter: one to send light through the test liquid to a enhancement layer, which is made of a thin gold film over a layer of nano-spheres, and second fibre to collected the signal. The sensor can identify a signature in the signal which is unique to the molecule it is designed to measure. A method called surface-enhanced Raman scattering amplifies the signal and makes it possible to see even small amounts of the molecule.



Microscopic image of the sensor probe configuration

So far Milenko and her colleagues have tested the sensor by measuring the concentration of a dye, but the next step is to move on to measuring glucose itself. “Glucose is actually really difficult to measure in the levels that they are in the body, because of its very low concentration,” says Milenko. Despite the challenges, she says preliminary experiments the group have yet to publish suggest that the sensor can in fact pick up glucose.

For the next step in their research, the team are using hollow fibres, created by researchers at the University of Bath, in the sensor. The idea is that, because the hollow fibres have more favourable optical properties they should provide better sensitivity to glucose.

Milenko hopes the eventual artificial pancreas will be able to respond to changes in blood-glucose levels quicker than existing devices that go under the skin, because it will be placed in a part of the abdomen called the peritoneal cavity. “There is some research showing that the glucose levels, if you measure them in the peritoneal cavity, will have a faster response,” she says.

Continuous monitoring would also be an advantage of the device, because the on-demand testing many people use now doesn’t give them the complete picture of their blood sugar levels. “Even if you do it many times per day, you still might miss the times in a day where your glucose is too high or too low, for example, when you are sleeping, or when you're doing some activities, and you're not able to measure that specific moment,” says Milenko.

It will still be a number of years before the team has a fully functioning device – but for many people with diabetes, it will hopefully have been worth the wait.

Kelly Oaks, August 2020