Needle-free glucose monitoring a step closer for diabetics

November 10 2021

Credit: CC0 Public Domain

A needle-free technology that would allow people with diabetes to measure blood sugar levels without having to stick a needle into their fingertips, has been bought closer to reality by researchers at the

Auckland Bioengineering Institute (ABI), University of Auckland, New Zealand.

The researchers turned their attentions to needle-free jet injection, an emerging but well-developed technique in which a drug is delivered directly with a high-speed narrow jet of fluid. In a study published in the *Journal of Diabetes Science and Technology*, led by ABI researchers Jiali Xu and James McKeage, researchers demonstrated for the first time that a jet injector could also be used to collect blood samples from humans—that is, release enough blood for glucose sampling, sans needles.

People with diabetes typically need to measure their blood glucose concentration several times each day. They do so by pricking their fingers with a needle to release a drop of blood. A glluclose meter then indicated how much insulin is required for the person to maintain their blood sugar.

Fingertips are the preferred site for blood sampling because they have a high density of blood vessels. But the fingertips are also sensitive, and pain, skin damage, bruising and risk of infection from regular 'pricking' has spurred increasing efforts to develop needle-free methods of blood testing for people with diabetes.

Jet injection has been the subject of years of research by the ABI Bioinstrumentation Lab at the ABI, University of Auckland, which includes developing jet injectors for delivering drugs such as insulin, nicotine, and as local anesthetic for dental treatment.Ms Xu and her team demonstrated that the technology could also be used to pierce the skin with a small volume of harmless saline solution, and this would release enough blood for glucose concentration measurement—that is, for extraction rather than injection.

The study involved 20 healthy participants, who each volunteered four fingertips, each of whom received a lancet prick (the standard needle) and jet injection through three differently shaped and sized nozzles. "These were were designed to mimic the wound left from a lancet prick, in the anticipation that it might release blood in a way similar to a lancet prick," says Ms Xu.

The study showed that indeed it did, with some nozzle shapes performing better than others—a 'slot' shaped nozzle released more blood than a circle-shaped nozzle, for instance. Most of the different jet injection nozzles were generally perceived as no more painful than a standard lancet, and in some cases, less so: participants were blinded by an opaque barrier that prevented them from seeing the procedure but allowed them to communicate with the practitioner. They were also asked to complete a questionnaire 24 hours later, to reassess the level of pain, swelling or bruising.

"When you know there's not a device that is pricking your skin, you could speculate that people will find jet injection more acceptable," says Professor Andrew Taberner, head of the Bioinstrumentation Lab at the ABI, and Ms Xu's supervisor. "But we don't have evidence to back that up. That wasn't part of this study. We were first trying to find out if it worked, and it did."

He was pleased, but not surprised. "Diesel mechanics have known for years that you should never put your finger in front of a fuel injector, because it will inject fuel into your finger. They found this out the hard way. But we're taking advantage of what diesel mechanics discovered accidentally years ago, with a very small amount of harmless liquid, to deliberately release blood."

The team is now investigating if they can use jet injection not only to release blood, but to suck back, to extract fluid. This would allow for the

design of an even smaller nozzle. They have the technology, having developed the world's first jet injection device that uses electric motors to pressurize the drug—this allows for more precise control than the more common spring-actuated jet injector.

"Our technology has the capability to both deliver and withdraw fluid. No other jet projection technology has that capacity," says Dr. Taberner.

Research into needle-free injections is a long game, as is the potential commercialisation of the technology he says, but he believes Ms Xu's research will contribute to the ultimate aim, of the development of a single lancet-free reversible technology that will allow for both blood sampling and insulin delivery based on the glucose measurement in one device. "I hope that this research will contribute to that, and the improvement in human healthcare, especially in the management of diabetes," says Ms Xu.

More information: Jiali Xu et al, Jet-Induced Blood Release From Human Fingertips: A Single-Blind, Randomized, Crossover Trial, *Journal of Diabetes Science and Technology* (2021). DOI: 10.1177/19322968211053895

Provided by University of Auckland