Alternatives to Traditional Glucose Measurement Devices

By Jeremy Brousseau

Today, more than eight percent of the population has been diagnosed with diabetes. The disease causes over two hundred-thousand deaths each year. While, it is currently incurable, it is also treatable. Diabetes related deaths are, for the most part, cause by stroke, hearts attacks, and other ailments of that nature. By monitoring the disease, and taking care of the problem at its source, many of these lives could be prolonged. Diabetes is caused my a malfunction in the body's ability to produce insulin, causing an imbalance in the levels of glucose in the body. Glucose, sugar, changes the chemical composition of blood and provides the various systems of the body with what they need. Too little glucose, and the organ systems cannot create enough ATP to run. Too much glucose can cause clotting and heart attacks, among other issues.

Methods for measuring glucose levels today are a far cry from those of the past. Home kits make the process much easier. But they are still flawed. Finger pricks are painful, and because of this people often don't use them as often as they should. Irritating your fingertips seven times a day, when you use your fingers constantly can be a hassle. New improvements in technologies have allowed less blood to be used, meaning that it can be taken from other areas, such as the forearm. However, random testing like this has proven to often cause the opposite extreme of the spectrum, hypoglycemia. Blood sugar can drop too low, because the patient is only rarely monitoring their levels. Continuous testing methods paired with automatic insulin distribution can solve this issue.

There are three categories of devices in the advanced stages of development. They are implantable monitors, transdermal devices, and devices that use spectroscopic methods. Implantable devices come in two different types. The first is blood-based, and the second is interstitial based. Blood based implantable devices have small tubes that pierce directly into the vein and take small samples of blood for measuring glucose levels, much like the finger prick devices we use now, only continuous. Interstitial based devices sample the interstitial fluid between cells. The first implantable sensor providing continuous sampling was made in 1999 by Medtronic MiniMed Inc. It can be seen in the figure below. Implantable devices work better than the occasional finger prick, but have issues of their own. A device that exists on the outside of your body and connects to something inside, can cause damage in high activity situations, especially for children.

Transdermal devices are devices that rest on the surface of the skin and take readings through the skin. Cygnus Inc. created a device like this in 2001. Essentially the watch-like device sends a current through the skin every twenty minutes, and reads the resistance due to glucose. It subtracts from this the resistance due to sweat and calculates the amount of glucose in the blood. This is fairly simple and not at all invasive, but it, too, has its drawbacks. The device can only work three times every hour for twelve hours before it needs to be recharged and the ionic cartridge, the part nearest to the skin, needs to be replaced. This causes problems for anyone who would like continuous night readings as well as day readings, and it can become expensive.

Recently, scientists have been investigating the properties of infrared light and other spectroscopic methods on the human body to detect glucose levels. While this stage is a bit further from having an actual marketable device, it is showing promise. The theory is that it works much like finger oxygen level sensors, only with glucose. The main problem developers are facing is a noise issue. The infrared is a wave that can penetrate easily through the skin. However, it also penetrates too easily through the glucose. Also, there is a method that combines the use of ultrasound with the transdermal testing. Ultrasound is used to open the pores, and a transdermal device is used to basically suck the blood through the pores.

Finally, a method that may appeal to the masses, but is new, and has far to go before it is a reliable method, is nano-tattoos. Nano-tattoos are nano capsules filled with three parts – a color changing die, a test particle, and a glucose mimic. If glucose is present, the test molecule attaches to it, turning the die yellow. If glucose is not present, the tester attaches to the mimic, turning the die purple. The useful part is that it can re-sample every few milliseconds.

Resources

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