<u>**SMART INSULIN PATCH:**</u> <u>A PAINLESS APPROACH TO TREAT TYPE II DIABETES</u>

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INTRODUCTION

A new device with micro needles smaller than the width of a human hair can inject doses of insulin into the bloodstream whenever the blood sugar levels need to be adjusted.

Painful insulin injections could become a thing of the past for the millions who suffer from diabetes, thanks to a new invention from researchers at the University of North Carolina and NC State, who have created the first "smart insulin patch" that can detect increases in blood sugar levels and secrete doses of insulin into the bloodstream whenever needed. The patch - a thin square no bigger than a penny - is covered with more than one hundred tiny needles, each about the size of an eyelash. These "micro needles" are packed with microscopic storage units for insulin and glucose-sensing enzymes that rapidly release their cargo when blood sugar levels get too high.

The study, which is published in the Proceedings of the National Academy of Sciences, found that the new, painless patch could lower blood glucose in a mouse model of type 1 diabetes for up to nine hours. More pre-clinical tests and subsequent clinical trials in humans will be required before the patch can be administered to patients, but the approach shows great promise.

They have designed a patch for diabetes that works fast, is easy to use, and is made from nontoxic, biocompatible materials. "The whole system can be personalized to account for a diabetic's weight and sensitivity to insulin that could make the smart patch even smarter.

Diabetes affects more than 387 million people worldwide. Patients with type 1 and advanced type 2 diabetes try to keep their blood sugar levels under control with regular finger pricks and repeated insulin shots, a process that is painful and imprecise. "Injecting the wrong amount of medication can lead to significant complications like blindness and limb amputations, or even more disastrous consequences such as diabetic comas and death."

Researchers have tried to remove the potential for human error by creating "closed-loop systems" that directly connect the devices that track blood sugar and administer insulin. However, these approaches involve mechanical sensors and pumps, with needle-tipped catheters that have to be stuck under the skin and replaced every few days. Instead of inventing another completely manmade system, Gu and his colleagues chose to emulate the body's natural insulin generators known as beta cells. These versatile cells act both as factories and warehouses, making and storing insulin in tiny sacs called vesicles. They also behave like alarm call centers, sensing increases in blood sugar levels and signaling the release of insulin into the blood.

"They constructed artificial vesicles to perform these same functions by using two materials that could easily be found in nature,"

The first material was hyaluronic acid or HA, a natural substance that is an ingredient of many cosmetics. The second was 2-nitroimidazole or NI, an organic compound commonly used in diagnostics. The researchers connected the two to create a new molecule, with one end that was water- loving or hydrophilic and one that was water- fearing or hydrophobic. A mixture of these molecules self-assembled into a vesicle, much like the coalescing of oil droplets in water, with the hydrophobic ends pointing inward and the hydrophilic ends pointing outward.

The result was millions of bubble-like structures, each 100 times smaller than the width of a human hair. Into each of these vesicles, the researchers inserted a core of solid insulin and enzymes specially designed to sense glucose.

In lab experiments, when blood sugar levels increased, the excess glucose crowded into the artificial vesicles. The enzymes then converted the glucose into gluconic acid, consuming oxygen all the while. The resulting lack of oxygen or "hypoxia" made the hydrophobic NI molecules turn hydrophilic, causing the vesicles to rapidly fall apart and send insulin into the blood.

Once they designed these "intelligent insulin nano particles," they had to figure out a way to administer them to patients with diabetes. Rather than rely on the large needles that had beleaguered previous approaches, they decided to incorporate these balls of sugar-sensing, insulin releasing material into an array of tiny needles.

Who It's For

Type 1 diabetes is usually diagnosed in childhood or early adulthood. In type 1 diabetes, the pancreas is incapable of producing insulin. People with type 1 diabetes are dependent on insulin therapy for life.

Managing this disease requires continual monitoring of blood glucose levels and calculating how much insulin is needed. Even just one day of inattention or a miscalculated dose of insulin can cause glucose levels to skyrocket or plummet. Either way, it can have a catastrophic effect on the body.

In the short term, low blood sugars can cause symptoms such as shakiness, dizziness, confusion, and so on. In the long term, complications include nerve, kidney, and eye damage. Managing blood sugar with frequent blood sugar checks and insulin injections requires a constant attention.

That's where smart insulin can help. Insulin that can sense glucose levels and correctly calculate its own dose would significantly ease the burdens of people who are dependent on insulin therapy to live.

How It Works

In order to be successful, smart insulin must be able to accomplish two things. It has to be able to sense glucose levels in the bloodstream and respond by releasing the right amount of insulin just when it's needed, and stop when it is not. It also has to work throughout the day regardless of diet, exercise, stress, or daily activities. If it can accomplish these things, it should be able to keep glucose levels in the safe zone.

Although smart insulin is not yet a reality for people with diabetes, researchers have made some progress. For example, scientists have developed an injectable form of the medication. The medication's core is made up of insulin. When blood sugar levels go up, the nanoparticles that surround the insulin break down and allow the insulin to be released into the body.

In 2013, researchers studied on the effects of this "smart" insulin system in mice. The results, published in ACS Nano, showed that it was able to keep blood sugar levels within a healthy range for up to 10 days.

EFFECTIVENESS OF SMART INSULIN PATCH

Regular insulin is an active molecule that begins to work almost as soon as it hits the bloodstream, but this new "smart insulin" is able to travel in the bloodstream in a dormant state, only turning on when the PBA molecule senses glucose. The new, painless patch could lower blood glucose in a mouse model of type 1 diabetes for up to nine hours. a patch for diabetes that works fast, is easy to use. This insulin activates only when there are traces of excess glucose in the bloodstream, an innovation which could potentially eliminate or lower the risk of hypoglycemia.

CONCLUSION

The study found that the new, painless patch could lower blood glucose in a mouse model of type 1 diabetes for up to nine hours. More pre-clinical tests and subsequent clinical trials in humans will be required before the patch can be administered to patients, but the approach shows great promise. "If the research can get these patches to work in people, it will be a game changer which will revolutionize insulin treatment for type 1 diabetes".

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