Implantable Glucose Responsive Insulin Delivery Device for Treatment of Animal Diabetes

The Advantages

In the absence of a definite cure for diabetes mellitus and easier management for the disease in animals, an effective insulin therapy would be an artificial closed-loop system able to control insulin release continuously and automatically as a direct response to blood glucose levels. This would provide the diabetic animals with the right amount of insulin in real time. An ideal system of this type would consist of a small, implantable and self-regulated device with the ability to compensate for the natural capability to infuse insulin without the requirement of external triggers.

The Problem

Canine Diabetes is an endocrine disorder, which is seen in cats, dogs and other pets and animals. Animals, just like humans can acquire Type 1 or Type 2 diabetes, a disease that requires daily management and in most cases treatment. However in these cases the burden and difficulty of administering treatment and costs associated with treating the disease are on pet and animal owners.

Type I diabetes occurs when there is a lack of insulin production and secretion by the pancreas. This form is identified in approximately 50 to 70% of cats diagnosed with diabetes mellitus. This form requires insulin injections to control the disease. In these cases most cats will require one or two daily injections of insulin to control blood glucose. Dogs nearly always (99%) have the type I variety and require one or two daily injections of insulin a day. These injections are given under the skin using a small needle. Dogs tend to get diabetes early in life. For instance, juvenile-onset diabetes (Type 1) may occur in dogs less than 1 year of age. Cats tend to get diabetes later in life. Although diabetes usually affects middle-aged to older cats it may also occur in cats less than 1 year of age. Type II diabetes occurs when enough insulin is produced but something interferes with its ability to be utilized by the body. This form is identified in approximately 30% of cats with diabetes mellitus.

In order to maintain blood glucose levels within the normal range, diabetic animals need to have insulin administered periodically prior to meals or when it is needed as indicated by glucose level examination. As animals cannot do this for themselves, their owners have to make sure that their animals are getting the proper treatments at very specific times. The process is painful and uncomfortable for the animals, can be inaccurate and inconvenient, and is the responsibility of the pet owner to fully take care of treatment for these animals. Therefore, alternative ways of treating these animals that allow for more effective and accurate treatment, more comfortable for the animals and lesser

Patent Status

There is an issued patent on the platform nanocomposite membrane technology for the delivery of drug molecules in response to certain stimuli. The issued patent number is #US6565872.
burdens on pet owners is needed. Research has been conducted actively in past decades to explore better ways of monitoring glucose concentration and delivering insulin continuously and automatically. New innovative delivery solutions for treatment of animal diabetes would definitely address the needs of this market.

**The Solution**

Dr. Wu’s group at the University of Toronto has developed a closed-loop glucose sensitive insulin delivery system that can mimic the pancreatic function of blood glucose homeostasis with the design and fabrication of a prototype implantable device. The device is ideal for treatment of diabetes in animals as it overcomes the limitations described above and would better manage the disease. Also Dr. Wu has shown the device to be safe and effective in diabetic rats over extended periods of time and the device can easily be translated to larger animals.

Owing to its nano-composite structure and a unique fabrication method, the device based on a membrane system offers advantages of fast response, high enzymatic activity, and a high immobilization yield. The membrane integrated with an insulin reservoir forms a glucose-responsive insulin delivery system that allows for tightly controlled regulation of glucose. The device is easily implanted under the skin or in the peritoneal cavity.

**The Business Opportunity**

To partner with or license the technology to a pharmaceutical company with a focus on animal health and treatments that has the interest and capabilities of moving this technology into the animal diabetic market.

**Significant Findings**

For *in vivo* tests, the devices were intraperitoneal implanted in STZ-induced diabetic rats. Glucose levels and plasma insulin were monitored three times a day.

- The device released insulin *in vivo* for up to 8 days (a longer period can be achieved by refill). Rats implanted with insulin-filled device showed higher levels of plasma insulin than the sham group throughout the implantation period.
• The implantation of the insulin device caused a dramatic effect on the glycemic control of the diabetic rats compared to the sham. The blood glucose of the group was regulated in the normal level (80 - 110 mg/dL) for up to 6 days.

• The glucose-regulation capability of the device was demonstrated in vivo by challenging implanted rats with glucose. Upon the glucose injection the blood glucose level of the rat was increased from normal to hyperglycemic level; after less than 20 min the glucose was decreased to normal levels due to the action of insulin delivered from the implanted device.

The Literature


