

Emerging Technologies in Diabetes Research

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Early Artificial Pancreas Trials Show Overnight Benefits for Kids, Teenagers with Diabetes

In a landmark study in children and teenagers with type 1 diabetes, JDRF-funded researchers at the University of Cambridge showed that using a first-generation artificial pancreas system overnight can lower the risk of low blood sugar emergencies while sleeping, and at the same time improve diabetes control.

The Cambridge study was actually three in one, as it encompassed three separate trials of a closed-loop system: overnight control, overnight control after eating, and overnight control after exercise. The study was published in February 2010 in the prestigious U.K. journal *The Lancet*, available at www.thelancet.com.

Conducted in a hospital, the trials tested the overnight safety and effectiveness of a first-generation artificial pancreas system in young people with type 1 diabetes. The system combined commercially available blood glucose sensors and insulin pumps with a sophisticated computer program called an algorithm. The program determined the insulin dosage to deliver, based on blood glucose levels while the participants slept.

Maintaining recommended blood sugar levels overnight is a major challenge for people with type 1 diabetes – and particularly for parents of children with diabetes – because of the possibility of blood glucose dropping dangerously low during sleep and going unnoticed, which can lead to seizures, coma, and in some cases can be fatal.

Main findings and implications

The Cambridge study showed that children and teenagers spent twice as much time during the night within targeted blood glucose levels when their diabetes was regulated with the artificial pancreas system than when they followed conventional “manual” therapy. And low blood sugars were minimized.

“These studies show that automated systems not only can help people manage diabetes by maintaining good control, they will also improve quality of life for the people with

type 1 diabetes and their families by lowering the risk for hypoglycemia,” said Roman Hovorka, Ph.D., principal investigator and lead author of the study from the Institute of Metabolic Science at the University of Cambridge. “These results suggest that closed-loop devices may be able to significantly lower the patient’s risk of developing complications later in life by reducing or even overcoming the burden of hypoglycemia.”

“Without a doubt, the biggest worry for parents of kids with type 1 diabetes is that their child will have a low blood sugar emergency during the night, when they’re hard to identify,” said Aaron Kowalski, Ph.D., Director of the JDRF Artificial Pancreas Project. “This study is proof-of-principle that diabetes in kids can be safely managed overnight with an artificial pancreas. We need to redouble our efforts to move the artificial pancreas from a concept in the clinic to a reality in the homes of kids and adults with type 1.”

The Cambridge study comes a few months after two JDRF-funded studies on continuous glucose monitors (CGMs) were published in the journal *Diabetes Care* – the newest data revealed that regular CGM use improves blood glucose control in all age groups and enables long-term control while lowering rates of hypoglycemia.

There are now five separate studies documenting the benefits of CGM and artificial pancreas systems – underscoring the importance of continued research into a closed-loop artificial pancreas, a system that includes CGM technology as one of its key components.

A closer look

The first phase of the Cambridge study compared the effectiveness of an artificial pancreas system used overnight with standard blood testing and insulin delivery using a pump. It showed that the time participants spent within target blood glucose levels (between 70 mg/dL and 140 mg/dL) improved from 39% to 52%. The second phase of the study evaluated the effects of using the same artificial pancreas system overnight with the additional variable of the participants eating a particularly large meal, which can impact overnight blood glucose levels. The results were comparable. The third phase of the study evaluated

the effects of moderately intense exercise, which can also influence blood sugar levels. These trials showed the greatest improvement in blood sugar control, with the amount of time spent in the target range increasing from 48% to 78%.

“The pooled data from the closed-loop studies showed that blood glucose levels were 61% in target, and even increased to 75% in target after midnight when closed-loop became fully effective,” said Dr. Hovorka. “Based on these results, this study is a significant step towards an artificial pancreas.”

The Cambridge studies were randomized, controlled trials involving 17 children and teenagers ages 5 through 18. Twelve participated in the first study; six in the second, and nine in the third. Some 33 nights were completed on a closed-loop artificial pancreas system, while 21 nights were completed on controlled (standard therapy). During the closed-loop studies, continuous glucose measurements were fed into a computer program every 15 minutes, which calculated the insulin infusion rate; the insulin pump was adjusted manually by a research nurse. During control nights, the subjects’ standard insulin pump settings were applied.

Research has shown that good blood sugar control is a key factor in reducing the risk of the devastating long-term complications of type 1 diabetes, such as blindness and kidney disease – but that the fear of low blood sugar emergencies often prevents many people from achieving tight control and remains a constant concern for those who manage their diabetes well.

Driving Towards an Artificial Pancreas

In January, JDRF announced an innovative, non-exclusive partnership with Animas Corporation to develop an automated insulin delivery system—a first-generation artificial pancreas—that will help people with type 1 diabetes better control their disease; Animas is a Johnson & Johnson company and a leading pump manufacturer. We featured this historic announcement in a special issue of *Emerging Technologies* at www.jdrf.org/Animas.ET.

Only a week after the Animas announcement, JDRF announced a second partnership, this time with BD (Becton, Dickinson and Company), a leading global medical technology company. This new partnership is aimed at developing novel insulin delivery products to enhance insulin pumps. Through the program, JDRF will support BD’s research and development of new products

that deliver insulin from a pump to a patient in either an infusion set or patch-pump configuration. The project includes research on microneedles, tiny needles that deliver insulin just beneath the skin, increasing the speed of insulin uptake; microneedles also may be virtually pain-free. Research indicates that there are significant opportunities to enhance pump therapy by improving convenience as well as minimizing pain, kinking, occlusions, and site infections. Advances in pump technology will not only lead to better diabetes control and reduced risk of complications, but can potentially be incorporated into an artificial pancreas developed by Animas or by other companies committed to finding cures and treatments for type 1 diabetes. To read more about this newest JDRF partnership and more, please visit our Artificial Pancreas Project website at www.artificialpancreasproject.com.

Ask A Researcher

As a resource for type 1 patients and their families and to encourage conversation about the Artificial Pancreas Project, JDRF recently launched an interactive online feature called Ask A Researcher: Questions Answered. Each month, JDRF researchers answer another question about diabetes technologies and artificial pancreas systems. If you wish to join the dialogue, please visit www.jdrf.org/askaresearcher and type your question into the question box. Previous questions include:

- Can you tell me more about participating in the artificial pancreas trials? Where are they being performed and do they study children?
- I have a question about the algorithms that are being developed. How will a computer algorithm deal with the variability in my diabetes? I try to do the same thing every day and still see big swings in my glucose.

JDRF has launched the Artificial Pancreas Project to accelerate the availability of an artificial pancreas to people with diabetes, one of the foundation’s cure therapeutic pathways. The overall goal of the project is to accelerate the development, regulatory approval, health insurance coverage, and clinical acceptance of continuous glucose monitoring and artificial pancreas technology. The long-term goal is for broad patient access and a thriving competitive market for these devices and products.

For regular updates about the Artificial Pancreas Project, please visit www.artificialpancreasproject.com.