Haven’t Got Time for the Pain
What’s new and in the works for pain-free diabetes management
by Bill Dupes

It’s no secret to people with diabetes what a pain that monitoring their blood sugar can be. The standard method requires several pinpricks a day to obtain small blood samples for testing. Doctors often complain that even their most diligent patients don’t test themselves as often as they should. A pain-free testing system has been the ultimate goal for many years, but there are a number of new products in the works to accomplish just that.

Envisioning the Future of Controlling Diabetes

The Carrot and Joystick Approach. Gluco Boy® is a glucose meter that can be inserted into a Nintendo Game Boy®. The product operates independently of the video game system but would download video games into the Game Boy as a reward for children who maintain good blood sugar control.

Here’s Looking at You, Kid. Someday, monitoring your blood sugar level may be as easy as looking in the mirror. Several research groups are competing to make this a reality. Their ultimate goal is to create a contact lens containing a sensor that can be worn by anyone, even people who don’t need vision correction.

A team of researchers from the University of Pittsburgh has developed a thin plastic sensor that can detect changes in glucose levels in body fluids. The novel material consists of a crystalline array embedded in a watery gel. Materials in the gel bind with glucose to form a complex of molecules. The presence of this complex causes more bonds to form within the gel, which changes the way light passes through it. Changes in glucose concentration create color shifts across the visible range. A normal glucose level imparts a green color to the sensor, extremely low concentrations induce a red color, and dangerously high levels cause it to turn violet.

CIBA Vision is in the early developmental phase of a daily contact lens that would be able to detect glucose levels. The concept involves flashing a light over the wearer’s eye; the lens would change color to reflect the person’s blood sugar level. However, it could be several years before the lens is on the market.

Bioengineers at the University of Maryland are looking at several design options similar to the ones previously described. For example, the group is working on a contact lens that would change color in reaction to glucose levels over a wider color spectrum (from green to yellow to orange to red), enabling the wearer to determine a broader range of blood sugar levels. In a variation of CIBA Vision’s design, the wearer would also use a handheld device that flashes a light at the eye. In this case, however, rather than having the entire contact lens glow, tiny sensor spots could be placed around the contact lens. These spots could monitor glucose, as well as sodium, cholesterol and potassium.

Researchers at Smart Holograms in Cambridge, England, are working on contact lenses that, again, incorporate design elements already described. Changes in tear sugars would deform an insert in the lens, altering the refractions from imperceptible dots on the surface. Next on their “To Do” list? A lens that detects blood pressure.
Finally, a Tattoo You Can Be Proud to Show Your Mom. Gerard Cote, of Texas A&M University, and Michael Pishko, of Penn State University, are developing a “smart tattoo” for people with Type 2 diabetes that can monitor glucose levels around the clock and alert the wearer when his or her glucose level is dangerously low.

Regular tattoos consist of ink particles that are taken up by the cells in the skin. In this case, however, tiny polymer beads coated with fluorescent molecules are injected under the skin. Because the polymer molecules are slightly larger than ink particles, they don’t enter the cells but remain in the fluid that surrounds them. “This is important,” says Dr. Cote, “because the level of glucose in the fluid is directly related to blood glucose, whereas the glucose inside the cells would be nearly nonexistent because it is almost immediately converted to energy.”

Because glucose displaces the fluorescent molecules, the level of fluorescence would be high when bodily glucose levels are low. Fluorescence levels could be measured using a device, such as a watch, that could also give users a readout of their glucose level.

But, like many traditional tattoos, the ideal location would be where the sun doesn’t shine. Because the tattoo is a fluorescent-based device, constant or frequent exposure to sunlight would degrade its performance. The arm or abdomen would probably be the most suitable location. Currently, the tattoo is in development and has only been tested on animals. Human testing is expected within the next five years.

I’ve Got You Under My Skin. A similar, and even less visible, device may have the potential to detect multiple chemicals at the same time. “The vision of our work is a passive sensor of virtually unlimited lifetime that could be placed in the tissue of the skin,” says Craig Grimes, PhD, a professor of electrical engineering at Penn State University.

Originally designed as an inexpensive device to continually monitor blood glucose levels, the passive sensor is smaller than a dime and would require no internal power supply or connections outside the body. The sensor is based on magnetoelastic technology, like the plastic security tags used in stores to prevent shoplifting, which are sensed wirelessly as they pass through an exit. Whenever a reading is needed, the wearer can wave a hand or arm in front of a reader that will automatically detect the sensor.

Magnetoelastic sensors can be considered the magnetic equivalent of a bell. When a bell is struck, it rings at a characteristic frequency.

If you coat the bell with a layer of paint, the frequency changes. In the same way, the molecules in a magnetoelastic sensor vibrate in the presence of a magnetic field, and the frequency varies with different chemical coatings.

Insulin Without Tears or Fears

Under Pressure. Although many people may assume that needle-free drug delivery is an idea straight out of science fiction, the idea has actually been around for quite a while. The first patent for a jet injection system was granted in the 1930s and insulin was first administered in this way in 1947.

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There’s nothing wrong with traditional needle-based injections; they’re tried and true delivery systems for medications. However, for a growing number of people such as those newly diagnosed with diabetes or who are tired or phobic of using needles, the concept of a needle-free delivery system is gaining popularity. Although a variety of models are available, they all operate on a common principle: using pressure to create a microthin stream of medication that penetrates the skin and is deposited into the subcutaneous (fatty) tissue in a fraction of a second.

Besides the obvious advantage of taking insulin quickly and without pain, jet injectors can administer insulin throughout a larger area of tissue than needle-based syringes, which means a quicker absorption rate. In addition to individual benefits, using needle-free technology would benefit the community as well by reducing the risk of needle-stick injuries and lowering the associated demand for safe disposal.

However, they’re not necessarily for everyone. Most people do feel a sensation when using jet injectors, and some have even stated that they felt pain only slightly less than what they experienced with traditional injections.

Breathing a Little Easier. The American Diabetes Association (ADA) estimates that nearly 21 million people in the United States have diabetes. About 5 million need insulin injections. But the ADA adds that about 15 percent of people with diabetes don’t take insulin as they should.

These people will be excited to learn that Exubera, the first inhalable version of insulin, won federal approval earlier this year, giving millions of adults with diabetes an alternative to some of the injections they now endure. But they shouldn’t throw out the needles and pumps just yet.

The use of rapid-acting inhaled insulin will not replace the need to inject the hormone occasionally, according to the Food and Drug Administration (FDA). And people will have to continue checking their blood sugar levels.

In clinical trials, Exubera, developed by Pfizer Inc., managed blood sugar levels just as well as injected insulin, but needles are still recommended to allow a patient to control dosage more precisely.

The FDA review panel expressed concern about the bulkiness of the dispenser (about the size of an eyeglasses case) and about some patients who experienced coughing or a slight decrease in lung capacity when using the drug. Pfizer will study Exubera’s long-term effects on the lungs, as well as its safety and effectiveness in patients with lung disease.