Explaining My Wife's Diabetes

by
J. Wanless Southwick, Ph.D.

It really bothered me when my wife started defining herself as a diabetic! How could she go from grandmother to diabetic in so few days? She let me sit in on sessions with her doctor and diabetes counselor. In answer to my many questions about this most common form of diabetes, we received lots of brochures, white papers and even the loan of a hefty book on diabetes. Although diabetes is a complicated disease, I formed a useful mental image of Type 2 Diabetes to guide our actions as my wife overcame her diabetes.

Decorated with Sugar

Her doctor's diagnosis used a test called HbA_{1C}, which the doctor said was a three-month average of blood sugar (glucose) levels. At first I couldn't understand how a single blood test could give a three-month average. Now I visualize all "new-born" red blood cells being permanently decorated with a sprinkling of glucose as soon as they enter the blood stream. If there's lots of glucose in the liquid blood, the decoration attached to the outside of their cell membranes is heavy. If there's not much glucose in the blood, the decoration is light. Each new blood cell wears its original decoration of glucose until it dies about three months later. So one test can measure the average amount of glucose that decorates red blood cells, which range in age from new-born to ready-to-die, thereby indicating what blood sugar levels were like during the previous three months.

So how did my wife's blood sugar levels get so high that it could be dangerous to her health? The short answer is that she was "fat" and sedentary. I take credit for the sedentary part, because for years she wanted us to begin an exercise program, but I think I should let her take credit for the "fat" part. She was not grotesquely obese, but she had a generous layer of padding twixt her skin and bones.

Attacking the Problem

We bought her a blood sugar testing kit and the medicine that her doctor had prescribed. With the gentle persuasion of my benevolent skepticism, she delayed starting the diabetic medication for a week while we tested and recorded her blood sugar several times each day. We used our computer's spreadsheet to graph the tests results to see differences before and after medication started. The graph verified that the medication lowered her blood glucose levels, but sometimes it got too low and she felt "shaky." Following the diabetes counselor's advice, she began to restrict how much she ate and paid careful attention to the number of "carbs" (carbohydrates) that she consumed. I remodeled a spare bedroom where we put a treadmill for exercise.

I wasn't the only one who was surprised by how much weight she lost with her careful control of her diet. Over the next nine months, she dropped from over 180 pounds down to about 140 pounds. At 160 pounds her doctor told her she could quit taking diabetes medication. She continued exercising and testing her blood. Her diabetes was under control and she looked trim! It was fun to see her timidly shop for new, slimmer clothes.

Visualizing Diabetes
Here's my simple mental image of the cause and cure of my wife's Type 2 Diabetes. It may not be a perfect model for such a complex disease, but it fits our experience and the diabetes literature we've studied:

Carbohydrates in our diet (sugars and starches, which are sometimes called "carbs") are essentially short or long chains of glucose molecules. Digestion breaks the chemical bonds in the carbohydrate chain and releases glucose molecules individually into the blood stream. You can read this paper because your brain cells are absorbing glucose from your blood and "burning" it to power the work of reading. Just as burning gasoline in a car produces power, heat, and exhaust, so burning glucose inside a brain cell produces brain power, body heat, and carbon dioxide "exhaust" in your exhaled breath. Just as gasoline needs to be replaced to keep a car running, so glucose needs to be replenished to keep brain cells functioning.

Whose turn is it?
The human body has some wonderful, self-regulatory mechanisms (called homeostasis). Blood sugar regulation is a good example. The body regulates blood sugar to keep it above the minimum required for proper brain function (about 55 mg/dL) and below the maximum that the blood-filtering kidneys can handle (about 140 mg/dL). Glucose is the brain's primary energy source. The brain absorbs glucose from the blood ***without*** the aid of insulin. Insulin, which is produced by the pancreas, tells liver, muscle and fat tissues when it is their turn to absorb glucose from the blood. Those three tissues are where the body stores most of its energy fuels. Unchecked those storage tissues could take so much glucose out of the blood that the brain and other organs couldn't function properly.

Insulin Presses the "Door Bell"
After a meal, high levels of glucose in the blood stimulate the pancreas to produce insulin. I picture an insulin molecule arriving at an energy storage cell, finding the right place to press itself against the cell's outer membrane, which (like pressing a door bell button) sends a biochemical message into the cell that glucose is available. The cell reacts by sending glucose transporters (GLUT4 molecules) through special areas of the cell membrane to identify and "hook up" with glucose molecules that are on the outside of the cell. The GLUT4 molecules then pull glucose molecules through the cell membrane into the interior of the cell. The storage cell then converts glucose into either glycogen or energy-rich fat, depending on which type of cell it is. Liver and muscle cells convert and store glucose as glycogen. About 1% of the body's expendable energy is stored in the liver; about 2 ½ % is stored in the muscles, but most (about 96%) is stored as fat in fat tissues.

Between meals, the brain gets its glucose energy mainly from the liver. The liver converts stored glycogen back into glucose, which the blood then transports to the brain. Muscles keep a supply of glycogen readily available inside themselves for quick bursts of energy when the body needs to accelerate into motion. When glycogen energy is drained from

liver and muscles, energy is drawn from fat cells. Meals replenish liver and muscle energy stores and the excess glucose goes into fat. Logically, we need to consider the problem of what could happen if a body's liver, muscles and fat tissues became completely full! Glucose in the blood from a meal would have no convenient place to go, so it would accumulate at high levels in the blood.

Ballooning Fat Cells

"Insulin resistance" is a characteristic of Type 2 Diabetes. We could imagine that if liver, muscle and fat cells are filled to capacity with stored energy, they could resist insulin's biochemical message to take in more glucose. Some medications can force more glucose out of the blood into storage cells. I envision those poor fat cells being pumped up like big tight balloons! A low "carb" diet can help lower blood sugar levels by reducing the amount of glucose put into the blood by digestion. If, however, the low "carb" diet just substitutes fat-based calories for carbohydrate calories, the dietary fat will go to fat cells for storage, causing more ballooning. My wife's alternative was serious attention to how much she ate and regular exercise. Weight loss, by reducing the amount eaten, can transform tightly inflated fat cells into shriveled fat cells that are ready and willing to respond to insulin's biochemical message to take glucose out of the blood. Exercised muscles use up their stored glycogen and are ready to draw blood sugar into themselves when insulin and glucose show up together in the blood. Reduced food intake and increased exercise make space for glucose. Insulin encounters less resistance as it does the job of clearing excess glucose from the blood. Liver, muscles and fat cells turn glucose into useful energy storage for the body. The natural, self-regulatory mechanisms for blood sugar just don't work well in a "fat," unexercised human body, and Type 2 Diabetes results.

Diabetes is a complex group of diseases that share elevated blood sugar levels as a defining symptom. Causes of diabetes differ among people. What worked for us will not work for everyone diagnosed with diabetes. My wife keeps her new slim figure with her low calorie diet and regular exercise. She's convinced that's the reason her blood sugar levels now stay within the proper range. I confess that she pokes my fingers for blood to check my blood sugar levels. She restricts my diet and has me take my turn on the treadmill. I suppose weight loss and exercise might even help me….