Strike the Spike:
NEW AND IMPROVED

by Gary Scheiner MS, CDE

I’ve always enjoyed writing for Diabetes Self-Management. Their editorial staff allows plenty of space to cover topics with sufficient detail, and they have always given me the creative license to “tell it like it is”.

Five years ago, I was asked to write about the management of after-meal blood sugar spikes. “Can’t you come up with a sexier topic than that?” I asked. “Something involving new high-tech devices or weird things people do in a hypoglycemic state?”

“Shut up and do as you’re asked,” they said. So I did. And I’m glad. Because no article I’ve ever written has led to greater reader response. To this day, I still receive many calls, letters, and e-mails thanking me for offering practical answers to this perplexing challenge. I’ve even been asked to speak on the topic at some major conferences. Heck… one of the families that frequent the Children With Diabetes meetings refers to me as the “Strike The Spike Guy”.

So, when presented with the opportunity to readdress the issue, I jumped at the chance. A lot has changed in the past five years: We know more than ever about the harmful effects of after-meal blood sugar spikes, but we also have a number of potent new tools and techniques for preventing them. And now that I know how meaningful it is to so many people, I’ll do my absolute best to provide some answers.

What’s A Spike? And Why Do They Happen?

Postprandial spikes are temporary high blood sugars that occur soon after eating. It is normal for the blood sugar to rise a small amount after eating, even in people who do not have diabetes. However, if the spike is too high, it can affect your quality of life today and contribute to serious health problems down the road.

The reason blood sugar “spikes” very high after eating for many people with diabetes is a simple matter of timing. In a non-diabetic, consumption of carbohydrate results in two important reactions: the immediate release of insulin into the bloodstream, and production of a hormone called amylin. Insulin produced by the pancreas starts working almost immediately and finishes its job in a matter of minutes. Amylin keeps food from reaching the intestines too quickly (where the nutrients are absorbed into the bloodstream). As a result, the moment blood sugar starts to rise, insulin is there to sweep the extra sugar into the body’s cells. In most cases, the after-meal blood sugar rise is barely noticeable.

However, in people with diabetes, the situation is like a batter with very slow reflexes facing a pitcher who throws 98 mph fastballs: the timing is all fouled up. Rapid-acting insulin that is injected (or infused by a pump) at mealtimes takes approximately 15 minutes to start working, 60-90 minutes to “peak”, and four hours or more to finish working. And don’t forget about the amylin hormone effect. In people with diabetes, amylin is either produced in insufficient amounts or not at all. As a result, food digests even faster than usual. This combination of slower insulin and faster food
can cause blood sugar to rise quite high soon after eating. This is followed by a sharp drop once the mealtime insulin finally kicks in.

Why are Spikes a Problem?

Even though the spike is temporary, all of those spikes throughout the day can raise your HbA1c. Since the HbA1c reflects an average for all times of day (not just before meals), after-meal spikes can cause your overall average to go up. For example, if your pre-meal blood sugar average is 130 but your post-meal average is 240, your HbA1c will probably reflect an overall average somewhere in the middle. In fact, research has shown that for those with an A1c below 7.5%, post-meal readings actually have a greater influence on A1c than fasting blood sugars. In other words, managing pre-meal readings will only get you so far. If you want tight control, you need to pay attention to the after meal numbers as well.

The long-term effects of postprandial hyperglycemia have been studied extensively. For those with type-1 diabetes, significant post-meal rises have been shown to produce earlier onset of kidney disease, and accelerate the progression of existing eye problems (retinopathy). And like a dagger through the heart, post-meal hyperglycemia is an independent risk factor for cardiovascular problems for those with type-2 diabetes.

But the problems are not limited to long-term complications. Any time blood sugars rise particularly high, even temporarily, our quality of life suffers. Energy decreases, brain function falters, physical/athletic abilities become diminished, and moods become altered. An Australian study of young people with type-1 diabetes indicated that short-term high blood sugar negatively affects thinking performance, coordination, and emotions/moods. A study conducted on people with type-2 diabetes showed that sharp rises in blood sugar slowed mental performance, lowered attention, reduced energy levels, and led to feelings of sadness and tension.

Unfortunately, the effects of single bouts of post-meal hyperglycemia do not go away immediately when the blood sugar returns to normal. Each high blood sugar can actually alter the way certain genes function, resulting in the production of harmful chemicals called “free radicals” that cause inflammation and damage to the lining of blood vessels for hours, if not days. So clearly, post-meal spikes represent a challenge worth of our attention.

Measurement & Goals

The exact timing of blood sugar spikes can vary from person to person and meal to meal. However, on average, the post-meal peaks tend to be about one hour and 15 minutes after starting a meal. So checking your blood sugar (using a fingerstick) about an hour after finishing a meal should provide a good indication of how much of a spike is taking place. Check before and after breakfast, lunch and dinner several times to determine how much of a spike is taking place. It is most common to see significant spikes after breakfast, but check after each meal just to assess what is happening.

When interpreting your numbers, take the pre-meal readings into account. A high or low reading before the meal will usually contribute to a higher reading after the meal. For example, a pre-meal blood sugar of 210 followed by a 1-hour post-meal reading of 240 shows just a 30-point rise, whereas a 110 followed by a 240 shows a 130-point rise. Lows before meals usually affect rates of digestion and may trigger a hormonal “rebound” to produce much higher readings.
So exactly how high is TOO High? There is no universal consensus on this issue. The American Diabetes Association recommends keeping blood sugar below 180 mg/dl 1-2 hours after eating. The European Diabetes Policy Group recommends keeping below 165 mg/dl at the peak, and the American Association of Clinical Endocrinologists and International Diabetes Federation suggest keeping below 140 mg/dl after eating. However, no specific guidelines are provided for type-1 vs. type-2 diabetes, insulin users vs. non-insulin users, or children vs. adults.

Based on my experience, I would recommend the following:

<table>
<thead>
<tr>
<th>Group/Age</th>
<th>Post-Meal Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults taking mealtime insulin</td>
<td>&lt;180 mg/dl (10 mmol)</td>
</tr>
<tr>
<td>Adolescents (12-18)</td>
<td>&lt;200 mg/dl (11 mmol)</td>
</tr>
<tr>
<td>School Age children (6-11)</td>
<td>&lt;225 mg/dl (12 mmol)</td>
</tr>
<tr>
<td>Preschool/toddlers (&lt;5)</td>
<td>&lt;250 mg/dl (14 mmol)</td>
</tr>
<tr>
<td>Type 2s not taking mealtime insulin</td>
<td>&lt;140 mg/dl (8 mmol)</td>
</tr>
</tbody>
</table>

Post-meal readings that are consistently above these levels should be addressed by you and your healthcare team (see strategies in the sections below).

Besides taking fingerstick blood sugars after meals, a few other options exist for analyzing post-meal spikes. Continuous Glucose Monitoring (CGM) systems from Medtronic, Dexcom and Abbott provide glucose readings every couple of minutes and provide trend graphs that make it easy to see exactly what is happening after meals. See example below:

CGM can be purchased for long-term/ongoing use. Some specialized diabetes centers offer them on a temporary/loaner basis just to get a sense of what is happening with your blood sugar at all times (feel free to contact my office for a loaner if your providers do not offer them). CGM systems include a tiny sensor filament placed just below the skin, a small radio transmitter attached to the sensor, and a handheld receiver that displays your data. The systems are all downloadable to a computer for analysis of the information.

Another way to assess after-meal blood sugar control is through a blood test called “GlycoMark”. Just as an HbA1c measures average blood sugar for the past few months, GlycoMark measures the degree to which blood sugars are spiking over the past couple of weeks. GlycoMark measures the level of a specific type of sugar that becomes depleted whenever the kidneys are spilling sugar into the urine (typically when BG exceeds approximately 180mg/dl). Ask your diabetes doctor if this test is available near you.

Spike Control: Medical Approaches

“Hey, doc. My sugars are spiking really high right after I eat. What should I do?”

“Simple. Just take more insulin.”

Unfortunately, this is the approach that many physicians take. Unless blood sugars remain high for 3-6 hours after eating, taking more insulin is not going to solve the problem. When temporary spikes are taking place, increasing the mealtime insulin would most likely result in a low blood sugar before the next meal.

To reduce the spike, a number of strategies can be used. Some involve medications while
others involve our lifestyle choices. Here are a few medical approaches:

1. Choose the right insulin (or medication)

The right insulin or medication program can make or break your ability to control those after-meal spikes. In general, insulin and medications that work quickly and for a short period of time will work better than those that work slowly over a prolonged period of time.

For instance, rapid-acting insulin analogs (Humalog, Novolog or Apidra) which start working 10-15 minutes after injection and peak in about an hour will cover the post-meal blood sugar rise much better than Regular insulin which takes 30 minutes to begin working and 2-3 hours to peak. If you use a morning injection of NPH insulin to “cover” the carbs eaten in the middle of the day, your postprandial blood sugar is likely to be very high. This is also the case if you take a premixed insulin (75/25, 70/30 or 50/50) twice daily. Instead, consider taking a rapid-acting insulin before each meal/snack along with a “basal” insulin such as Lantus or Levemir.

Your choice of oral medication can also impact your after-meal control. Sulfonylureas (glyburide, glipizide, glimepiride) stimulate the pancreas to secrete a little extra insulin throughout the day, without regard to meal timing. Because these medications fail to concentrate the insulin secretion at times when it is needed most, after-meal blood sugars can run very high. There are alternative medications called meglitinides (Repaglinide, Nateglinide) which also stimulate the pancreas but do so in a much faster and shorter manner. When taken at mealtimes, meglitinides produce better after-meal control.

Another class of diabetes medications (alpha-glucosidase inhibitors) improve after-meal control by partially blocking the transport of sugars across the intestines and into the bloodstream. However, these medications can sometimes cause gas, bloating and g.i. upset, so the “pros” don’t always outweigh the “cons”.


For those taking rapid-acting insulin at mealtimes, the timing of the bolus can have a huge impact the after-meal spikes. Boluses given too late to match the entry of sugars from dietary carbohydrates can produce significant hyperglycemia soon after eating, whereas a properly timed bolus can result in excellent after-meal control.

Unless you suffer from gastroparesis (a nerve disorder that slows emptying of the stomach), it is best to give boluses before eating. How long before? It depends… mainly on what you are eating and your pre-meal blood sugar level.

The blood sugar part is easy to interpret. The higher your blood sugar, the earlier the bolus should be given. With pre-meal blood sugar that is well above your target, it is best to give the bolus and then wait an extra 30 minutes before eating. Near your target blood sugar? Wait 15 minutes. Below target? Either take the bolus and eat right away, or take the bolus after eating.

The type-of-food part is a bit more complex. Essentially, the more rapidly-digesting the food, the earlier the bolus should be given. Rate of digestion is measured by something called “glycemic index,” or “GI”. Foods with a high GI (greater than 70), such as cereal, bread, potatoes, rice and snack chips,
tend to raise blood sugar the fastest, with a significant “peak” occurring in 30-45 minutes. For these types of foods, it is best to bolus 15-20 minutes prior to eating. This will allow the insulin peak to coincide as closely as possible with the blood sugar peak.

Foods with a moderate GI (approximately 45-70) digest a bit slower, resulting in a slightly less pronounced blood sugar peak approximately 45-60 minutes after eating. Examples include ice cream, orange juice, cake, carrots, pizza, and complex mixed meals. It is best to bolus 5-10 minutes prior to foods with a moderate GI.

Foods with a low GI (below 45) tend to cause a slow, gradual blood sugar rise. The blood sugar “peak” is usually modest, and may take an hour or two. Examples include pasta, milk, yogurt and chili beans. For these types of foods, bolusing right at the start, during, or right after the meal usually works best.

The chart below combines the glycemic index and pre-meal blood sugar to determine optimal timing of mealtime insulin:

<table>
<thead>
<tr>
<th>Bolus Timing In Relation to Meal</th>
<th>High GI</th>
<th>Moderate GI</th>
<th>Low GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG Above Target</td>
<td>30-45 min. prior</td>
<td>20-30 min. prior</td>
<td>15-20 min. prior</td>
</tr>
<tr>
<td>BG Within Target</td>
<td>15-20 min. prior</td>
<td>5-10 min. prior</td>
<td>At start of meal</td>
</tr>
<tr>
<td>BG Below Target</td>
<td>5-10 min. prior</td>
<td>At start of meal</td>
<td>10-15 min. after meal</td>
</tr>
</tbody>
</table>

Does earlier bolusing make a difference? Absolutely. Research has shown that simply giving mealtime boluses before eating rather than after can reduce the post-meal spike by about 50 mg/dl.

3. Bolus for the Basal

In order to have more insulin working right after eating and less working several hours later, a pump user can run a substantial temporary basal reduction for 3 hours just before eating and give a normal bolus equal to the basal insulin that would have been delivered. John Walsh, coauthor of the Pumping Insulin books, calls this a “Super Bolus”. For example, if your basal rate in the morning is .6 units per hour, you could bolus an extra 1.8 units before breakfast and then suspend the pump, set a temp basal of 10% (90% reduction), for the next 3 hours.

4. Ride the “-Tides”

Two injectable hormones, Byetta (exenatide) and Symlin (pramlintide), have powerful effects on post-meal blood sugar. Both hormones slow gastric emptying and keep carbohydrates from raising the blood sugar too quickly after meals. Symlin, which is a replacement for the amylin hormone that is missing in people with type-1 diabetes, also helps to diminish appetite and blunt post-meal glucagon secretion. Byetta also blunts appetite and promotes the growth of insulin-producing cells in the pancreas of those with type-2. So both Symlin and Byetta provide a focused effort on reducing post-meal blood sugar spikes.

Lifestyle Approaches to Stop the Spikes

1. **Think Lower GI.**

As mentioned earlier, glycemic index (GI) refers to the speed with which food raises the blood sugar level. While all carbohydrates (except for fiber) convert into
blood sugar eventually, some forms do so much faster than others.

Many starchy foods (breads, cereals, potatoes, rice) have a high GI; they digest easily and convert into blood sugar quickly. Some starchy foods (pasta, beans, peas) have lower GI values. Foods that have dextrose in them tend to have a very high GI. Table sugar (sucrose) and fructose (fruit sugar) have moderate GI values, while lactose (milk sugar) is slower to raise blood sugar. A number of books, such as Dr. Jennie Brand-Miller’s *Glucose Revolution* series, contain extensive information about the glycemic index, along with lists of GI values for hundreds of foods.

As a general rule, switching to lower-GI foods will help to reduce your after-meal blood sugar spikes. There are certain characteristics/properties that slow down the rate at which foods raise blood sugar. For instance:

- High-fiber foods digest slower than low-fiber foods
- Hi-fat foods digest slower than low-fat foods
- Solids digest slower than liquids
- Cold foods digest slower than hot foods

Another unique food property that affects rate of digestion is acidity. This is why sourdough bread has a much lower GI value than regular bread. Research has shown that adding acidity in the form of *vinegar* (straight or in dressing/condiment form) can reduce the one-hour post-meal blood sugar rise by 50% or more.

<table>
<thead>
<tr>
<th>Meal</th>
<th>High-GI Choices</th>
<th>Lower-GI Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>Typical cereal, bagel, toast, waffle, pancake, corn muffin, juice, breakfast bars</td>
<td>High-Fiber cereal, oatmeal, yogurt, whole fruit, milk, bran muffin, granola</td>
</tr>
<tr>
<td>Lunch</td>
<td>Sandwich/Sub, french fries, Tortillas, canned pasta</td>
<td>Chili, rye / pumpernickel / sourdough bread, corn, carrots, salad vegetables</td>
</tr>
<tr>
<td>Dinner</td>
<td>Rice, rolls, white potato, canned vegetables, beer</td>
<td>Sweet potato, pasta, beans, fresh/steamed vegetables</td>
</tr>
<tr>
<td>Snacks</td>
<td>Pretzels, chips, crackers, cake, cookies</td>
<td>Popcorn, fruit, chocolate, ice cream, nuts</td>
</tr>
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- High-fiber foods digest slower than low-fiber foods
- Hi-fat foods digest slower than low-fat foods
- Solids digest slower than liquids
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- Under-ripe and under-cooked foods digest slower than over-ripe/over-cooked foods
- Whole/natural foods tend to digest slower than processed foods

Above are some examples of ways to substitute typical high-GI foods for lower-GI options.

2. **Split your meal.** When having a meal and don’t want your blood sugar to rise all at once,
consider saving a portion of your meal for a “snack” one or two hours later. Still give the full mealtime insulin before eating any of the meal; just don’t eat all of the food at once. For example, if you have a bowl of cereal and juice for breakfast, considering having the cereal at breakfast time, and postpone the juice until midmorning.


Physical activity after eating can reduce post-meal spikes in a number of ways. If insulin was taken prior to the meal or snack, the enhanced blood flow to the skin surface is likely to make the insulin absorb and act more quickly. Muscle activity diverts blood flow away from the intestines, resulting in slower absorption of sugars into the bloodstream. Plus, the sugar that does enter the bloodstream is likely to be “consumed” by the working muscles.

How much activity is required to experience these benefits? Not much. Ten or 15 minutes (or more) of mild activity will usually get the job done. The key is to avoid sitting for extended periods of time after eating. Instead of reading, watching TV or working on the computer, go for a walk, shoot some hoops, or do some chores. Try to schedule your active tasks (housework, yardwork, shopping, walking pets) for after meals. Also attempt to schedule your exercise sessions for after meals. On “date nights,” resist the urge to sit and talk for hours or head straight for a movie. Instead, go out dancing, bowling or skating.

4. Prevent Hypoglycemia. Low blood sugar is problematic in many ways. One of the body’s typical responses to hypoglycemia is accelerated gastric emptying: food digests and raises blood sugar even more rapidly than usual. While this is certainly a desirable phenomenon (who wants to wait for food to kick in during a low?), it will definitely contribute to an excessive post-meal spike. Prevention of hypoglycemia prior to meals and snacks is yet another effective strategy for controlling post-meal blood sugars.

Time to Strike the Spike!

Given the many short- and long-term benefits of post-meal blood sugar control, it is certainly worth the effort to start measuring and evaluating your after-meal control. If your sugars are higher than they should be, talk with your healthcare team about new/different medical treatments that might help. And take a look at your personal choices in terms of food and activity. Even without a perfectly functioning pancreas, there is still a multitude of options for tackling those spikes!

Editor’s note: Gary Scheiner MS, CDE is Owner and Clinical Director of Integrated Diabetes Services, a private practice specializing in intensive insulin therapy. He is author of several books, including Think Like A Pancreas: A Practical Guide to Managing Diabetes With Insulin. He and his team of Certified Diabetes Educators work with people throughout the world via phone and the internet. Gary has had Type-1 diabetes for 25 and now relies on Symlin to help manage his post-meal blood sugars. He can be reached at gary@integrateddiabetes.com, or toll-free at 877-735-3648.