

Insulin-to-Carb Ratios Made Easy

by Gary Scheiner MS, CDE

For those who take rapid-acting insulin at mealtimes and want *any* degree of meal planning flexibility, it is necessary to apply something known as insulin-to-carb (I:C) ratios. Now, if the mere thought of having to do math at every meal sends shivers up your spine, don't despair. This is something that even the "mathematically challenged" can master in no time.

The Method Behind the Mathematics

One of the basic assumptions we make in the use of I:C ratios is that dietary carbohydrates, which include sugars, starches and fiber, are responsible for raising blood sugar levels after meals. Fiber, however, is usually not counted since it does not break down completely and does not raise blood sugar levels. And fat and protein have minimal short-term effects, particularly when consumed as part of a carbohydrate-containing meal.

The rapid-acting insulin that we give at mealtimes is designed to offset the blood sugar rise induced by the carbohydrates. In most cases, insulin analogs such as aspart (Novolog/Novorapid), lispro (Humalog) or glulisine (Apidra) are used at meals. However, Regular insulin

(Humulin R, Novolin R) may be used, but it tends to be less effective because of its slower action.

Whichever insulin is used, success comes from matching the dose to the amounts of carbohydrate eaten. This is where I:C ratios come in. The I:C ratio specifies how many grams of carbohydrate are "covered" by each unit of insulin. For example, a 1-unit-per-10-grams-of-carb (1:10) ratio means that one unit of insulin covers 10 grams of carbohydrate. A 1:20 ratio means that each unit covers 20 grams. Calculating a meal or snack dose becomes simple when you know your I:C ratio: Simply divide your carbs by your ratio. If each unit covers 10g and you have a modest 20g meal, you will need only 2 units of insulin ($20 \div 10 = 2$). If you devour 120g, you will need 12 units ($120 \div 10 = 12$).

Note that using an I:C ratio of 1:10 will result in larger doses than if you use a ratio of 1:15. A 30g snack will require 3 units if using a 1:10 ratio, but only 2 units if using a 1:15 ratio. As the second number in the ratio goes up, the amount of insulin goes down.

The beauty of an I:C ratio is that it gives you the flexibility to eat as much or as little

carbohydrate as you choose while still maintaining good blood sugar control. It is common to require different I:C ratios at different times of day due to changes in hormone levels (which affect insulin sensitivity), physical activity (which enhances insulin sensitivity) and the amount of basal / long-acting insulin overlapping with the mealtime insulin. For most people, insulin sensitivity tends to be a bit lower in the morning than later in the day. For example, I require a 1:10 ratio at breakfast, 1:12 at lunch, and 1:15 at dinner and in the evening. But if I exercise after dinner, my I:C ratio drops to 1:25.

Initial I:C Ratios

Two methods exist for choosing an I:C starting point. Whichever method you choose, it is best to begin with a conservative approach (i.e. lower insulin doses) in order to prevent hypoglycemia. It is easier to "tighten up" than it is to try adjusting when you're constantly recovering from low blood sugar.

The 500 Rule

This approach is based on the assumption that the average person consumes (via meals and snacks) and produces (via the liver) a total of

approximately 500 grams of carbohydrate daily. By dividing 500 by the average number of units of insulin you take daily (basal insulin *plus* mealtime insulin), you can get a reasonable approximation of your I:C ratio.

For example, if you take a total of 25 units of insulin in a typical day, each unit of insulin should cover approximately 20 grams of carbohydrate ($500 \div 25 = 20$). If you take 60 units daily, your I:C ratio would be 1 unit per 8 grams of carb ($500 \div 60 \approx 8$).

Avg. Units Insulin Daily (basal + bolus)	Approx. I:C Ratio
8-11	1:50
12-14	1:40
15-18	1:30
19-21	1:25
22-27	1:20
28-35	1:15
36-45	1:12
46-55	1:10
56-65	1:8
66-80	1:6
81-120	1:5
>120	1:4

The major weakness to this approach is that it assumes that all people eat about the same amount of food and produce the same amount of glucose each day. Those who are heavy and those who eat relatively large amounts of carbohydrate will underestimate their insulin requirement with this approach; those who are lean, active or light eaters will tend to

overestimate their mealtime insulin requirements.

The Weight Method

This approach is based on the general observation that insulin sensitivity decreases as body size increases. Thus, each unit of insulin will cover less carbohydrate in a heavier person than in a lighter person.

Weight (lbs)	Approx. I:C Ratio
<60	1:30
60-80	1:25
81-100	1:20
101-120	1:18
121-140	1:15
141-170	1:12
171-200	1:10
201-230	1:8
231-270	1:6
>270	1:5

One of the potential problems with this system is that it fails to consider body *composition*. An individual who weighs 250 lbs but is very muscular will be much more sensitive to insulin than a person of similar weight who has a great deal of body fat.

Fine-Tuning and Verifying I:C Ratios

It is best to confirm your basal insulin levels before attempting to fine-tune your mealtime I:C ratios. Any basal insulin changes made after fine-tuning your mealtime doses might send you right back to the drawing board.

Fine-tuning I:C ratios is best done empirically (through “trial and error”). And don’t forget to verify the I:C ratio at each meal and snack separately, as they can vary by time of day.

Keep detailed written records when testing your I:C ratios. Track your blood sugar level before each meal and then again 3-4 hours later (to give the insulin a chance to work fully) with no other food, exercise or rapid insulin given between the two blood sugar readings. It is best to eliminate factors other than food that might be affecting the results of the tests. For example, do not include data collected during or immediately after strenuous exercise. Also, don’t count data collected during an illness or major emotional stress, at the start of a menstrual cycle or after a low blood sugar. Meals with very high fat content or unknown carb content (such as restaurant meals) should not be used as part of your analysis.

Because strange things can happen on any given day, I like to consider 10-14 days of data when coming to a decision regarding the I:C ratio. Allow the carb content of your meals to vary somewhat, and continue to adjust your insulin doses based on your pre-meal blood glucose levels during your evaluation phase. Then go back and assess: Which I:C ratios tend to result in a blood sugar rise from one meal to the next? Which ratios result in a

drop? And which ones tend to hold your blood sugar steady? Steady is what you're looking for when choosing a ratio. Even if your blood sugar stays slightly high or slightly low, if it held steady from one reading to the next, the ratio is probably correct.

Don't Expect Perfection

Fine-tuning your I:C formulas can be a challenging proposition, even for the most highly trained and experienced person with diabetes. The more detailed you keep your records, the better. You might discover certain factors that have a subtle influence on your blood sugar levels: days of the week, work/school schedules, time of the month, physical/recreational activities, changes in pump infusion sets or insulin vials/cartridges, injection/infusion sites, dining in vs. out, medication schedules, and even social engagements.

Don't be surprised if there are a few "oddball" results when you analyze your data: an I:C ratio that makes you rise one day may make you drop the next. Remember, diabetes is not an exact science. There are countless variables to contend with, so don't hesitate to "throw out" results that are highly inconsistent with the rest of your data. The key is to look for trends and patterns in your data. Find an I:C ratio that produces near-normal

readings on most occasions and you've struck the equivalent of diabetes gold.

Given the complexities of determining bolus formulas, it is usually worthwhile to have a second set of eyes look over your records. Don't hesitate to ask your physician or diabetes educator to review your data and help you to form reasonable conclusions. My practice also offers this type of consulting service via phone, fax and the internet for those who don't have access to intensive diabetes self-management services locally.

Editor's note: Gary Scheiner is a Certified Diabetes Educator with a private practice near Philadelphia, specializing in intensive self-management training for children and adults who use insulin. He has had Type-1 diabetes for the past 22 years, and can be reached at 877-735-3648 or gary@integrateddiabetes.com, or visit his website: www.integrateddiabetes.com.