



Carbohydrate Counting: Basic to Advanced

A Web-based Training

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Introduction

Hello! I'm Brenda Broussard. I'm a Registered Dietitian, Certified Diabetes Educator, and Independent Healthcare Consultant. I'm a French Cajun from the wetlands of South Louisiana, transplanted to arid New Mexico where you can see I do some log surfing. I've been working in Indian Health and Diabetes at the tribal, area, and national level for over 30 years. I'm the daughter of a mother who died of the complications of Type 2 diabetes and the sister of siblings with diabetes.

I share your concerns about the epidemic of diabetes in our country and in Native American communities and the challenges people with diabetes face. As healthcare providers, we're on the front line assisting people with diabetes to learn self-management skill. We are coaches, educators, advocates, and clinicians.

If you ask our patients, "What's the hardest thing for you right now with your diabetes?" We'll get different answers. Research shows that the most frequent response is related to diet. Is that your experience?

Diet, healthy eating for diabetes has many facets. Today I'll be concentrating on one-meal planning approach: carbohydrate counting. I will discuss three levels from Carb Awareness, to Basic and Consistent Carb intake, to Advanced using carb-to-insulin ratios to calculate doses of mealtime insulin.

I asked Kelli Wilson, Registered Dietitian, to tell me some commonly reported foods of her patients at Wewoka Health Clinic in Oklahoma and here's what she said, "Many guys say they eat a honey bun with coffee for breakfast and many folks eat ramen, the whole block, not the half block as the package nutrition facts label states." So can you guess how many grams of carbs are in one packaged honey bun? And if you printed out the handout, you can write it right there. Well, in my market research, I found a range from 51 to 88 grams of carbs. The five-ounce honey bun at 7-Eleven has 72 grams of carbs.

Now can you guess how many carbs in a package of ramen noodles? Well, the package that's shown here says it's got 52 grams. One way to engage clients either individually or in groups is to ask, "What are some of your favorite foods or your most frequently eaten foods? And let's see how many carbs are in these foods." Now with the Internet, you can search online and many SDPI programs have purchased carb- and calorie-counting books for patients. What do you use?

Well, Medical Nutrition Therapy or MNT works. One of the first evidence-based studies on the effectiveness of MNT was led by Marion Franz and her colleagues in Minnesota. They reported that patients with Type 2 diabetes receiving nutrition therapy by registered dietitians experienced a decrease of one to two points in A1C at six weeks to three months. Clinical trials of MNT had reported decreases in A1C at three to six months ranging anywhere from one-fourth of a percent to 2.9% with the higher reduction seen in Type 2 diabetes of shorter duration. And we know this. We know that Medical Nutrition Therapy works best when a person is newly diagnosed.

We know that diabetes therapies work better with a meal plan. Carb counting is a meal planning approach used with clients who have diabetes that focuses on carbohydrate as the primary nutrient affecting postprandial blood glucose. Monitoring carbs is a key strategy in meeting glycemic goals. It was found to be effective in the landmark Type 1 study, Diabetes Control and Complications Trial. Carb counting can be used by patients with Type 1, Type 2 and Gestational Diabetes. Most of us work primarily with patients with Type 2 diabetes where the goal is to fit carb intake into a healthy and often hypocaloric meal plan.

For patients with Type 2 diabetes on insulin, the goal is to match the pre-meal insulin to the carb intake as well as pre-meal blood glucose level and exercise.

The levels of carb counting are tailored to the individual, just as we do with medications and glycemic goals. There are three levels of carb counting and if you could think of it as a continuum. Level one is carb awareness, level two is basic carb counting which promotes a consistent carbohydrate intake, and the third level is advanced. It's designed to teach clients using multiple daily injections or insulin pumps, how to match mealtime insulin to grams of carbohydrate using carb-to-insulin ratios and insulin correction factors.

Well first, as clinicians, as educators, we do an assessment of the patient. Has she met her A1C target? And it might be less than seven; it could be less than eight. Is self-monitoring blood glucose prescribed? And if yes, does she know when and how often to test and then what to do with the information? What's her typical meal pattern? Does she have one? Does she eat one, two, maybe three meals a day? Does she skip meals? What meds is she taking?

We know that carb counting takes some degree of health literacy and numeracy. Computational numeracy involves not only counting but being able to determine the number of grams of carbs in a serving from a food label and if glucose levels are within target range. And then critically, the ability to calculate that carb intake and adjust insulin dosage on the basis of the glucose values.

So again, what meal planning approaches do you use? The assessment that you do with your client will lead you to the next steps. So, is your patient interested in carb counting? And if yes, can you suggest some carb target ranges for meals and snacks with her? Does she need a referral to a registered dietitian to develop a meal plan that will work for her and her family?

This presentation concentrates on the effect of carbohydrates on blood glucose levels but there are other factors as well. For example, high-fat foods in meals will delay the rise of blood glucose. Incorrect insulin dose or any other medications, the injection site can make a difference especially if someone's being physically active. If they inject in their thigh, that would also make a change in their blood glucose levels. And of course stress and illness. You probably have other factors that you would consider.

Okay. So you have seen a patient newly diagnosed with diabetes. She's scared, maybe thinking that she can't eat sugar or white foods like bread and potatoes, so after addressing her emotional issues, she asks you, "What can I eat?" Well, what do you say? Here are some general recommendations you can offer to her. First step, if you will, for healthy eating with diabetes. People with diabetes are given many nutrition messages, not only from us as clinicians but from family, friends, the media.

Here are some priority messages for you to deliver. First of all, emphasize blood glucose control, not weight loss, blood glucose control. Choose healthy foods; at least five servings of fruits and vegetables, at least three servings of whole grains, two to three servings of low-fat or fat-free calcium-rich foods, two to three servings of lean protein, and unsaturated fats. Also avoiding skipping meals.

Now you've done an assessment. So now you can develop a meal plan with the patient. This helps determine how much carb, protein, and fat to eat at meals and snacks. Set an eating schedule. For example, eat three small- to medium-sized meals and include some carbs in each meal. Control portion sizes focusing on carb foods and number of servings per meal. Avoid liquid sugar like pop.

What does this look like? So I have up here up on the screen three meal plans to consider. There are many more but here's three general ones.

The first one, the "DASH Eating Plan" was originally developed by National Heart, Lung, and Blood Institute as an eating style to help lower blood pressure. It's been found to be a healthy meal plan for diabetes and weight management, and it has an emphasis on nutrient-dense foods.

The middle one is "My Native Plate". It is the Indian Health Service Division of Diabetes' adaptation of "Choose My Plate". And then at the bottom is "Mediterranean Style". It's a heart-healthy eating plan that includes whole grains, nuts, beans, vegetables, and monounsaturated fats.

Carb Awareness

The first level of carb counting is carb awareness. Can your patient identify foods and beverages that do and do not contain carbs? Can they identify carbohydrate as the primary nutrient affecting blood glucose level? The rise in blood glucose is affected by the amount of carbs consumed and the speed of digestion and absorption. We know that low glycemic index foods are slower to enter the bloodstream and dietary fat slows absorption. What we're talking about is a controlled-carb meal plan, not a low-carb meal plan. The recommended dietary allowance or RDAs for carbohydrate is set at a minimum of 130 grams per day for adults and children based on the minimum amount of glucose used by the brain. Most adults consume about 200 to 300 grams of carbs per day.

So what's the average percent of calories from carbs for people with diabetes? Take a guess. Is it 20%, 40%, 60%? Well, data from NHANES, the DCCT and Look AHEAD studies report that the average carbohydrate intake is 43% to 46% of total calories. The amount of carbs is individualized based on glycemic goals, nutrition goals, present eating habits, physical activity, and meds. Carb counting involves estimating accurately the amount of carbs in food servings.

Now, portions can be deceptive. Just one example; apples shown here on the screen. They come in many different sizes. According to nutrient data from USDA at the link showed below, an extra small apple, 2 1/2-inch diameter, has 14 grams of carb. A medium apple has 25 grams of carb and a large apple has over 30 grams of carb. Now I don't know how your grocery stores are in your area but in Albuquerque where I shop, it's almost always large or super large apples that are for sale.

So again, can your client identify what foods have carbs? These are the general groups: breads, cereals, grains, some starchy vegetables, dried beans and lentils, fruits, milk and yogurt, and of course, sweets, desserts, and regular sodas. And can he or she identify what foods have little or no carbohydrate? Non-starchy vegetables such as salad greens, broccoli, tomatoes, squash and peppers, meat, chicken, fish, eggs, cheese, tofu and other soy protein products, and fats and oils.

Now, a basic meal planning tool is the plate method. Here is "My Native Plate." It was developed by IHS DDTP and field-tested by many of you. You can use the plate method to promote carb awareness. For people who are less active, perhaps older, need to eat less calories. At meals, the guideline is to keep the starches, the rice, beans, pasta, and starchy vegetables to one-fourth of a plate and adding one serving of fruit and/or milk or yogurt.

For people who are active, younger, or want to stay at the same weight basically the starchy foods can fill half the plate and again adding a serving of fruit and/or a serving of milk or yogurt.

Are you searching for some new resources to use in your practice? IHS DDTP has tools on carb counting you can download to your computer or order from their online catalogue. I'm just going to highlight three tools. Again, this first one "My Native Plate", this is the second image of "My Native Plate." It provides a visual guide to help your patients eat balanced meals of reasonable portion sizes. You can use it as a starting point for nutrition education and to introduce healthy eating, not only for your client but for the whole family.

The upper left image shows four meals. You can use the tool to discuss portion sizes and carb counting. Now, two of the meals have about 50 grams of carb. If you'll look again up on the upper left image of "My Native Plate", the upper right is breakfast with one tortilla, which has 30 grams of carbs and a medium orange with 15 grams of carbs. And then on the bottom left image, it shows a lunch with one hamburger bun with 30 grams of carbs and a small apple with 20 grams of carbs.

Now underneath is a Tips Sheet for using "My Native Plate." One of the issues to consider is food insecurity, which can influence your patients to overeat available foods, skip meals, and/or choose inexpensive, high carbohydrate foods. I'm going to be giving an Advancements seminar on April 4th on the connection between food insecurity and diabetes. On the right is the cover of "Balancing Your Food Choices: Nutrition in Diabetes." It's a curriculum that includes teaching sessions on food labels and carbohydrate counting.

So how do you count carbs? You can either count grams of carbohydrate or carb choices. The equation we use is 15 grams of carbohydrate is equal to one carb choice. Now sometimes you will hear these terms "carb servings" or "exchanges". Two reliable websites for finding grams of carbs in foods are Calorie King and the USDA Nutrient Database. Estimating food portions can be tricky. Dietitians and diabetes educators often use food replicas or food models as a three-dimensional teaching tool to show portion sizes.

You know I was thinking about this last night as I was preparing dinner for my family. I was making spaghetti. I have difficulty identifying how much spaghetti is on a plate. My guess was close but not close enough if I had to calculate a mealtime insulin dose. I've taught some group classes and I've asked participants to guesstimate the portion size, and you know what? Their guesses are all over the board. It's best to practice a while to develop this skill. Encourage your patients initially to use measuring cups and spoons at home so that they can improve their estimation skills.

For example, measure out one-third cup of spaghetti on a plate. That represents 15 grams of carbs. That's probably not all you're going to have for the meal but say you're going to have a cup of spaghetti. Measure that out. Let's see what that looks like on a plate. It's important to ask clients to measure portions using their own plates, bowls, and glasses. I challenge you to estimate the amount of carbs you plan to eat tonight. Take a guess, then measure out the food or beverage and see how close you are to your guess. I recommend patients measure food portions at home for at least a week to get a feel for estimated portions and doing so every few months because we tend to underestimate the amounts.

Now, after knowing what foods contain carbohydrate, the next step is to learn about carbohydrate portion sizes. For example, what food has 15 grams of carbs? Here are some general guidelines. For example, a slice of bread, a half a cup of starchy vegetables such as potatoes, a small piece of fruit, two small sandwich cookies. You do count carbs as the non-starchy vegetables are eaten in large quantities. For example, three cups of salad or 1½ cups cooked vegetables. Now sugar-free beverages, sugar substitutes are free and don't contain carbs.

Basic: Consistent Carbohydrate Meal Plan

Level two is Basic Carb Counting and emphasizes a Consistent Carbohydrate meal plan. Individuals on nutrition therapy alone, glucose-lowering medications or fixed insulin doses do better when the carbohydrate intake is kept consistent on a day to day basis. This means eating three meals a day at consistent times with consistent carb intake. The amount of carbs is individualized based on nutritional needs of the individual and preferences. Glucose monitoring is recommended for patients on insulin therapy. The evidence base for SMBG for patients with Type 2 diabetes is somewhat mixed. For people with Type 2 diabetes, glucose monitoring can be used to determine whether adjustments in foods and meals will be sufficient to achieve blood glucose goals or if medications need to be combined with nutrition therapy.

Testing blood glucose pre-meal and two hours after the start of a meal can give your patient the information on the effect of that meal. For example, what would be the effect of having breakfast with two large pancakes and syrup compared to one with one large pancake and syrup? Patients ask me, "Brenda, can I eat cake? Can I eat ice cream? How much can I have?" And I tell them, "You know what? You need to see how your body responds. You need to test your blood glucose before and after to see the effect on your blood glucose."

Here are some general guidelines for the amount of carbs for a meal. Carb goals depend on diabetes medications, body weight, and the level of physical activity. On the left, for women, to lose weight, women need about 30 to 45 grams at each meal; to maintain weight, an extra 15 grams, and then for the very active, an extra 15 or more grams. Snacks need to be considered generally anywhere from 15 to 30 grams of carbs per snack. For men, on the right, again to lose weight, 45 to 60 grams per meal and you can see the same pattern flowing from there. Again, these are starting points for you to use with your patients. The aim is to have a consistent amount of carbs at each meal and at snacks if snacks are needed. For many patients, this will mean reducing the usual portion sizes.

A key counting aid for clients is the nutrition facts label. One of the most helpful tools you can offer to clients to interpret is being able to read the food label. Here is an example of one label, macaroni and cheese. First of all, we find the serving size. The serving size listed here is one cup. Then we compare the serving size to the actual portion eaten. We find the total carbohydrates and total carbs here in the white line in this example, 31 grams of total carbohydrate and 31 grams is equal to two carb choices. Now often clients will focus on sugar and you've probably seen that. Here we go. This is where they often focus and it's one of the first things I talk with patients about. We don't need to adjust for sugar because sugar, dietary fiber, and sugar alcohols are included in the total carbohydrates. We adjust for fiber and sugar alcohols if they're over five grams.

There are many books and websites that can provide nutrition information for foods that do not have a label. An additional one is the American Diabetes Association's website called MyFoodAdvisor. So here are some basic healthy eating resources for you to use with your patients. The American Association of Diabetes Educators has a series of diabetes self-care behavior sheets including one on healthy eating. I've got the links there for you. "Healthy Food Choices" is a mini-poster from the American Diabetes Association and International Diabetes Center has a basic resource called My Food Plan Made Easy.

Moving midway between basic and advanced carb counting resources, here are some other patient ed. resources: "My Food Plan" as well as – it's not pictured here but "My Food Plan For Gestational Diabetes." These are fold-up carbohydrate counting resources available for purchase from IDC. The third one, "Carbohydrate Counting" is a 31-page booklet. Each of these has a page for you to

customize a meal plan with your patient. DDTP is in the process of purchasing these resources and soon you will be able to order these and other materials from their online catalogue. So stay tuned.

The next one is “Ready, Set, Start Counting.” It’s a free downloadable brochure from the Diabetes Care and Education practice group of the Academy of Nutrition and Dietetics. It gives sample menus of 45 to 60-gram carbs per meal as well as 60 to 75 grams per meal. Now I think one of the best ways to engage patients and their families is to lead a small group on a grocery store tour as shown in this photo.

You’d be using your own local store, identifying healthy foods for diabetes, having patients read food labels, and then answering questions as you go down the aisles. Now many of you have been doing this successfully for years. One tool I developed for use in clinic is a three-ring binder that has about 40 nutrition facts labels of commonly eaten foods in the Albuquerque area such as tortillas. In fact, I have three different-sized tortilla nutrition facts labels. It’s a quick way to show patients at the visit how to interpret the label.

Now, we have the opportunity to help our patients effectively use mobile apps in their diabetes management. What better technology to use than that which is usually within arm’s reach? Carb counting apps also called “calorie counters” help patients easily look up the amount of carbohydrate grams found in foods in restaurant meals. Here are two apps that have received high marks. “Go Meals” has a large database of restaurant, grocery, and generic food items and it’s powered by Calorie King. It’s partnered with a restaurant locator and a food tracker. It also has a glucose log and activity tracker and it’s a free download. “MyNetDiary Diabetes Tracker” app has it all. It’s got a food database that tracks carbs, meds, blood glucose and it can create charts and reports. It costs about \$10.

Registered Dietitian and CDE, Emily Gilgen reported in the AADE newsletter about smartphone apps. As of July 2012, the three free carb counting apps with the most positive reviews; that is at least four out of five stars by patient are these listed here. For Apple apps, “Calorie Counter”, “Calorie King”, and another “Calorie Counter” by MyNetDiary. On the right you can see some for Android apps.

Initially, using the Consistent Carb meal plan will work well for your patients. Well, then your patients may come to you and say they want more flexibility. They don’t want to have to eat the same number of carbs every meal.

Advanced: Carb-to-Insulin Ratio

Advanced Carb Counting is a tool for those on multiple-dose insulin injection therapy, either multiple injections by syringes each day or use of an insulin pump as shown here. Advanced carb counting is designed to teach clients how to match fast-acting insulin to carbohydrate using carb-to-insulin ratios. It involves accurately calculating grams of carb. In this approach, again, it offers greater flexibility in food choices, portion sizes, and timing of meals.

I was surprised to learn that 31% of patients in Indian Health System are on insulin therapy. Type 2 diabetes is a progressive disease and for most patients, it means that over time, they will need insulin therapy. Requirements for successful, intensive insulin therapy are: first of all, for our patient to understand their blood glucose targets pre and post meal; ability to accurately count carbs in foods in the portions that they’re eating; and the motivation to make efforts to take the time required to record, calculate, test, reflect, analyze, adjust and retest; the ability to calculate a bolus insulin

dose using carb-to-insulin ratios and supplemental insulin dose using insulin correction factors. It requires all of us - coordinated care from a diabetes team including primary care providers, registered dietitians, diabetes educators and others trained in advanced practice. This can't be done in one or two visits as you know. It requires multiple visits, reinforcement, ongoing support, often phone calls, emails, and office visits to help patients make adjustments.

So a carb-to-insulin ratio helps to determine the bolus dose of fast-acting insulin to "cover" the carbs at a meal or a snack. It's the total grams of carbs disposed by or again "covered" by X units of insulin. So here's the formula: the number of grams of carb divided by the number of units of bolus insulin equals X grams of carb for every one unit of insulin.

So here are three methods to determine carb-to-insulin ratio. First one, quick and easy method, the second is the pattern management and the third is the rule of either 500 or 450. I found the UC San Francisco Diabetes Teaching Center's online site to be a great resource on calculating insulin dose and I have here the link on the slide.

Let's take a look at the Quick and Easy method. Clinicians determine the starting ratio. It could be 15:1, that is 15 grams of carb for one unit of fast-acting insulin. Every person responds differently to insulin. This means that any two people with diabetes can have different carb-to-insulin ratios. For some adults, one unit of rapid-acting insulin can usually cover 15 grams of carbs. For an individual with Type 2 diabetes and insulin-resistance, it may be a ratio of 10:1. For a young, thin person, it might be 20 or 25 grams of carbs to one unit of insulin. The ratios will vary across individuals and for the same individual with different meals, weight change, and hormonal swings.

So our second method is Pattern Management. In this method you review with the patient his food, insulin, and blood glucose records to estimate the carb-to-insulin ratio. You need a minimum of three days of records, optimally one week so that you can identify trends; meals where at least half of the pre- and post-meal blood glucose values are within target. Now here's the gram method that I described earlier.

Here's a case study. Your patient usually eats 70 grams of carbs for dinner and takes seven units of insulin. To determine the carb-to-insulin ratio, we divide the 70 grams of carbs by seven units of insulin to get a ratio of 10:1. Ten grams of carb would be covered by one unit of insulin. Now some points to consider as you review the patient's logbook; are there enough blood glucose checks recorded? Are there at least three blood glucose checks taken at the same time a day so that you can spot a trend? Are contributors to the blood glucose result consistent; for example, carb intake or dosing of insulin?

A third method to determine carb-to-insulin ratio is the 500 and 450 Rule. It's useful only for people with Type 1 because people with Type 2 diabetes usually produce some insulin naturally in addition to the insulin they inject. So a total daily insulin dose cannot be calculated reliably. The 500 rule is for rapid-acting and the 450 rule is for regular insulin. To calculate the carb-to-insulin ratio, you divide 500 by the total daily dose of insulin if you're using rapid-acting insulin and you divide 450 by the total daily dose if you're using regular. The result is the grams of carbs that are covered by one unit of insulin.

Case Study: The patient is taking a total of 50 units rapid acting insulin. So the equation is 500 divided by 50 equals 10 grams of carbs covered by one unit of rapid-acting insulin, for a ratio of 10:1. Charts such as this one are available online.

Let's practice. In this case study, your patient's carb-to-insulin ratio is 10:1 for breakfast, for lunch it's 15:1, and for dinner it's also 15:1. Your patient is on the run. She plans to eat at McDonald's for lunch and she looks up the carbs on her phone app. She plans to eat a cheeseburger and she again looked at her phone and she sees that it's got 35 grams of carbs, a small salad which has four, vinaigrette dressing which has three, one chocolate chip cookie which has 21 grams of carbs and a diet soda. So how many carbs is she planning to eat at lunch? We total it all up. It's 63 grams. And how much insulin should she take before lunch? Well, we would divide 63 grams of carbs by 15 because it's lunch and her carb-to-insulin ratio at lunch is 15:1. So 63 divided by 15 gives us 4.2 or rounded off it would be four units of fast-acting insulin before lunch.

Now to test, she would check her blood glucose two hours after the start of lunch, to see if her blood glucose within goal range. And if the two hours postprandial glucose is too high, she would decrease the ratio; that is less carbs per unit of insulin, for example, going from 15:1 down to 10:1 ratio.

There are a variety of apps for calculating carb-to-insulin ratio based on diabetes data that the patient enters into their phone or mobile device. Here are some screen shots for one Android app. It calculates separate ratios for breakfast, lunch, and dinner as you can see on the right here.

Well, what's an Insulin Correction Factor? Sometimes you'll see this term. You'll see it as "insulin sensitivity factor". It's used to calculate the amount of bolus insulin to bring blood glucose into target range. Now this adjusts or corrects the blood glucose that's either higher or lower than desired before a meal. Again generally, to correct the high blood glucose, one unit of insulin is needed to drop the blood glucose by 50 milligrams per deciliter. Now, we know that that really varies. It could range anywhere from 50 to 100 milligrams per deciliter or more, depending on the individual's insulin response.

There are some general blood glucose range targets from the American Diabetes Association Clinical Practice Recommendations shown here on the slide - pre-meal, a range of 70 to 130, post-meal, less than 180. For tighter control we might suggest to our patient a post-meal upper limit of 160 instead of 180. For patients who experience episodes of hypoglycemia, we might bump up those target ranges to minimize hypoglycemia and of course instruction on how to test and treat for low blood glucose.

We use the Insulin Correction Factor to determine the correction dose. Here's the formula: the current blood glucose minus the target blood glucose divided by the insulin correction factor. For example, for our patient, assume one unit will drop blood glucose 35 points. That's the Insulin Correction Factor. And again, at the pre-meal it was 190, it was higher than the target of 120. So the correction dose is the difference between the actual blood glucose minus the target blood glucose divided by the correction factor. In this case, it's 190 minus 120 over 35. That gives us two units of insulin. That means our patient's going to need an additional two units of rapid-acting insulin to correct the blood glucose down to 120.

Okay, so let's pull this all together. To calculate the total mealtime insulin dose, we add the carbohydrate coverage dose to the high blood glucose coverage dose. Remember again from our case study, our patient plans to eat 60 grams of carb. Her carb-to-insulin ratio is 10:1, so we divide 60 grams of carb divided by 10. She would need six units of insulin for that amount of carbs and assume one unit will drop her blood glucose 35 points. Pre-meal again just like we said we figured out the insulin correction dose as the difference between the actual blood glucose minus the target divided by the correction factor. We get two units of insulin. So we add the two doses together to calculate the total mealtime insulin dose. And that's how we get six units. Again that covers the 60

grams of carbs she's planning to eat plus two units for the high blood glucose correction dose. So her total bolus insulin coverage at mealtime is eight units of fast-acting insulin.

When using this method, the patient must be willing and able to correctly count the number of grams of carbs in a meal and divide by the assigned carb-to-insulin ratio to determine the number of units of insulin to take. Also, she must check blood glucose before the meal to determine how much insulin should be given or reduced as a correction dose if the blood glucose isn't at target. Insulin pumps are based on this concept of basal-bolus insulin administration and they have the capability of calculating a suggested bolus dosage based on inputted grams of carbs and blood glucose concentrations.

Now most studies related to carb counting had been in Type 1 diabetes, very few in Type 2. I found one study of individuals with Type 2 diabetes. Dr. Rich Bergenstal and his team at the International Diabetes Center compared a Single Algorithm to Carb Counting for adjustment of fast-acting mealtime insulin. It was a 24-week multi-center randomized control trial composed of two algorithms, adjusting mealtime insulin, along with a standard algorithm for adjusting basal insulin in 273 adults who had Type 2 diabetes for at least six months. At screening, these adults were taking two or more insulin injections a day. Both basal and bolus insulin were adjusted weekly in both groups based on self-monitored blood glucose results from the previous week, and I'll be showing you those algorithms in the next couple of slides.

Now the Simple Algorithm group was provided set doses of rapid-acting insulin to take before each meal. The Carb Counting group was provided a carb-to-insulin ratio to use for each meal and they adjusted their bolus insulin dose based on the amount of carbs consumed. Both groups had significant reductions in A1C.

For the Algorithm group, it was a reduction from 8.1 to 6.7. For the Carb Counting group, the reduction was from 8.3 down to 6.5. The total daily dose, which I have abbreviated here, total daily dose of insulin was lower in the Carb Counting group, 175 units compared to 207 units in the Algorithm group. Each group had a weight gain of five to eight pounds with less weight gain in the Carb group. The investigators reported that severe hypoglycemia rates were low and equal in both groups. In their paper, they concluded that using a Simple Algorithm to adjust mealtime insulin each week based on self-monitored blood glucose was as effective as adjusting based on insulin to carb ratio. So both methods of mealtime insulin dosing resulted in significant reductions in A1C.

Here you have two effective approaches to deliver and adjust fast-acting mealtime insulin which might increase our – as clinicians as well as our patient's willingness to advance therapy to a basal-bolus insulin regimen. Now this table again from Dr. Bergenstal's "Diabetes Care" journal article, it shows the basal insulin adjustments of insulin glargine for both groups. The adjustments were based on self-monitored blood glucose results from the previous week. Let's look at that first example. Here we go. Where the average of the last three-day fasting blood glucose values was over 180 milligrams per deciliter. Now that individual would increase their basal insulin by eight units.

Let's look at bolus insulin adjustments or mealtime insulin adjustments for both groups. The top chart is for the Simple Algorithm group and the bottom chart is for the Carb Counting group. Individuals in the Simple Algorithm group were provided set doses of rapid-acting insulin to take before each meal. For example, if the individual was taking greater than 20 units and the mealtime blood glucose was above average then you would increase bolus insulin by three units. The Carb Counting group was provided a carb-to-insulin ratio to use for each meal. Individuals adjusted their mealtime insulin dose based on the amount of carbs consumed.

For example, let's look at that first row under Carb Counting. If the mealtime dose was one unit for every 20 grams of carbs, and if the mealtime blood glucose was below target, then the individual would decrease to one unit for every 25 grams of carbs. If that mealtime blood glucose was above target then the mealtime dose would be increased to one unit for every 15 grams of carb.

Here are some resources for intensive therapy and advanced carb counting. I do recommend the book, "The Complete Guide to Carb Counting" from the American Diabetes Association. It's written by RD, CDE's Hope Warshaw and Karmen Kulkarni. It was updated in 2011. The second one, "Blood Glucose Pattern Control: A Guide for People Who Use Insulin", this booklet is good for you to use with your patients and it's soon going to be available through the DDTP online catalogue.

I hope I have whetted your appetite to learn more. If you want to delve more deeply into intensive therapy, I recommend these resources from the DDTP website: "When and How to Use Insulin Therapy in Type 2 Diabetes" by Dr. Bergenstal, it's a podcast; "Advanced Strategies in Diabetes Management", lots of case presentations by Dr. Habas, it's a recorded seminar; "Individualizing Diabetes Targets: One Size Doesn't Fit All" by Dr. Bullock, it's an advancements webinar and recently, Dr. Marie Russell gave an "Update on Self-monitoring Blood Glucose" in the Advancements series; and then of course "The Best Practice: Nutrition for Diabetes Prevention and Care."

Now I shared information on carb counting, different levels all the way from carb awareness to basic and consistent carbs to advanced level using total grams of carbohydrate, carb-to-insulin ratios, and insulin correction factors to calculate the dose of mealtime insulin. Our challenge is to get to know our patients. Yes, I know it means carving out sufficient time to determine if this meal planning approach is indicated and if yes, then to determine what level of carb counting is best. You can provide Basic nutrition guidelines. You can promote Consistent Carb intake. And if you're comfortable with Advanced Carb Counting, you can provide that to your patient.

Now especially for the consistent carb and advanced carb meal planning approaches, I recommend you refer your patients to a registered dietitian who's experienced in diabetes care. I wish you much success in your practice and I thank you for your attention.