Beyond Carb Counting:

The Relationship Between Glycemic Variability and Carbohydrates

Erin Caroulis, MPH, RD, LDN, CDE
Registered Dietitian, Certified Diabetes Educator

Objectives

- Define glycemic variability
- Nutrition goals for people with diabetes
- Understand differences between type and amount of carbs
- Define different types and benefits of dietary fiber
- Define Glycemic Index (GI) and Glycemic Load (GL)
- Explain how to incorporate GI and GL into diet

What is Glycemic Variability?

Spikes in glucose levels from pre-meal to post-meal

- Post-meal blood glucose checks 3 hours after start of meal

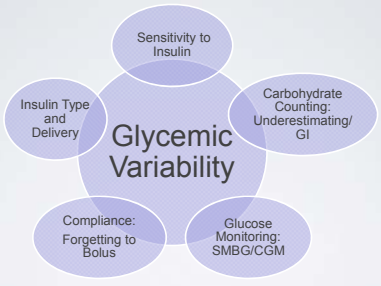
Questions to Ask...

- How long does the blood glucose stay high?
- How high does the blood glucose spike?

Both impact A1c-approximately 1% and contribute to diabetes complications

Managing Blood Glucose-Balancing Act!

What Effects Glycemic Variability?



How to Measure Glycemic Variability

CGMS (Continuous Glucose Monitoring System)

- Real-time Sensor

SMBG (Self-monitoring Blood Glucose)

- Post meal BG should be 50 points within the pre-meal BG
- Test 3 hours after starting the meal

Timing of Insulin and Carbohydrates

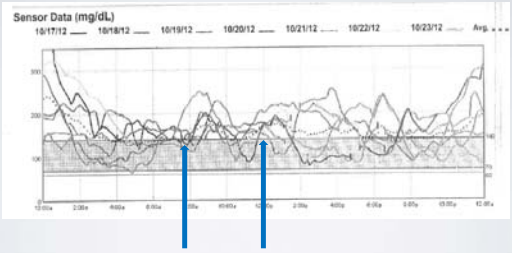
Carbohydrate Metabolism

- After first bite, BG levels increase within 10-15 minutes
- Peak within 60-90 minutes
- Takes 2-4 hours for BG to return to pre meal level

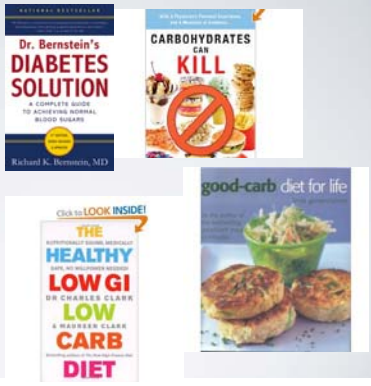
Timing of Insulin

- Pre-meal vs. Post-meal
- Lag Time- Realistic?
  - Inject insulin 10 minutes before meal (BG ~100)
  - Inject insulin 20 minutes before meal (BG ~200)
  - Inject insulin 30 minutes before meal (BG ~ 300)

Issues with Post Meal Dosing



What messages are you hearing?



Effect of Different Nutrients on Blood Glucose

Protein

- Minimal effect on blood glucose
- Eating large portions may require insulin

Fat

- Delays food digestion
- May result in delayed hyperglycemia

Carbohydrates

- Greatest impact on blood glucose
- High fiber, glycemic index and resistant starch may improve blood glucose

Goals of Nutrition Therapy for Adults With Diabetes

1. To promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, in order to improve overall health and specifically to:

- Achieve and maintain body weight goals
- Attain individualized glycemic, blood pressure, and lipid goals
- Delay or prevent the complications of diabetes

2. To address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful foods, willingness and ability to make behavioral changes, and barriers to change

3. To maintain the pleasure of eating by providing nonjudgmental messages about food choices

4. To provide an individual with diabetes the practical tools for de… eating patterns rather than focusing on individual macronutrients, micronutrients, or single foods

Amount of Carbs

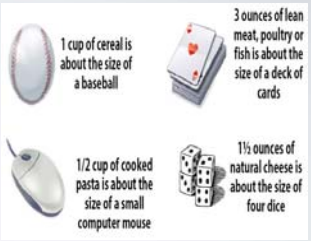
- Matching grams of carb to fast-acting insulin
  - Flexible approach to eating
- 45-65% total calories/day
  - ADA Position Statement at least 130 g carb/day

Accuracy of Carb Counting Effects Glycemic Variability

- Weighing Carbs
- Measuring Carbs
- Carbohydrate Factors

Can't Always Measure Carbs?

- Average adult's fist = 1 cup
- Baseball = 1 cup
- Child's fist = 1/2 cup
- Cupped hand = 1/2 cup
- Deck of cards = 3 ounces meat
- Half-pint of milk = 1 cup
- Tennis ball= ¾ cup



Not All Carbs Are the Same!

Types of Carbs

Refined/Simple	Whole Grain
• Milk • Fruit • Desserts • Sweets • Juice • Enriched Wheat, Unbleached Flour • Pretzels, chips, white bread/pasta/rice	• 100% whole grain bread, pasta, cereal, crackers • Brown rice • Popcorn • Quinoa • Barley/Buckwheat • Rye • Oatmeal and whole oats

Benefits to Eating Fiber Rich Foods

- Research shows eating 44-50 g dietary fiber/day improves BG compared to less than 24 g/day
- Not digested and absorbed
- Lower calories
- Improves fullness/weight management

How Much Fiber Do We Need?

DRI Fiber Recommendations

- 1-3 years: 19 g
- 4-8 years: 25 g
- 9-13 years: 26-31 g
- 14-18 years: 26-38 g
- 19-50: 25-30 g
- 50+: 21-30 g

Fiber Grams

- 1 medium apple with skin: 3g
- 1 medium banana: 3 g
- ½ cup cooked broccoli: 2 g
- 1 whole wheat tortilla: 2-5 g
- ¼ cup almonds: 3 g
- ½ cup Fiber One cereal: 14 g

Reading Food Labels

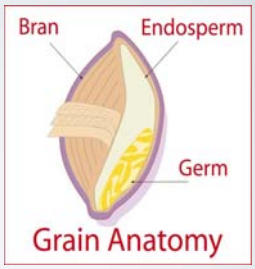
- Choose whole-grain products with 3 grams of fiber or more per serving

Are All Fibers Alike?

Blood Glucose Lowering	• Beta glucan (barley and oats) guar gum, psyllium, resistant starch, maltodextrin, inulin (**chicory root,** Jerusalem artichoke)
Improve Cholesterol and Reduce Inflammation	• Beta glucan (barley and oats), guar gum, pectin (citrus fruits), psyllium (Metamucil)
Improve GI Health (Prebiotic)	• Beta glucan (barley and oats), **inulin (chicory root,** Jerusalem artichoke), agave, pectin (fruit fiber), psyllium

White Whole Grain?

- Same nutritional advantages of traditional whole wheat, but with lighter color and milder taste
- Contains WHOLE flour – including the bran, germ and endosperm – made from WHITE wheat



Compare White Whole Grain vs. Whole Wheat

Nutrition Facts/2 oz dry
- Total Carbs: 43 g
- Dietary Fiber: 6 g
- Ingredients: Semolina (Wheat), Durum Wheat Flour, **Whole Durum Wheat Flour**, **Corn Starch**, Niacin, Iron (Ferrous Sulfate), Thiamine Mononitrate, Riboflavin, Folic Acid.

Nutrition Facts/2 oz dry
- Total Carbs: 41 g
- Dietary Fiber: 6 g
- Ingredients: **Whole Grain Durum Wheat Flour**, Semolina (Wheat), Durum Wheat Flour, Oat Fiber

Ways to Add Fiber

- Homemade trail mix with dried fruit
- Add fresh fruit to breakfast and dinner
- Mix bran or whole grain cereals with your favorite cereal
- Eat oatmeal for breakfast
- Mix Kashi into yogurt
- Add salad or raw vegetables before dinner
- Try whole wheat pasta or brown rice

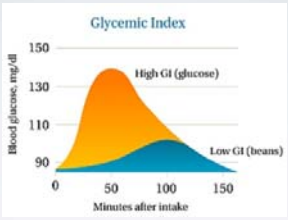
What is the Glycemic Index or Glycemic Load?

Glycemic Index (GI)
- Introduced in 1981
- Blood glucose response of a 50 g carb portion of a food compared to glucose or white bread

***Statement from the ADA**: "low-glycemic index diets can produce a modest benefit in controlling postprandial hyperglycemia"*

Glycemic Load (GL)
- The effect of a portion of food has on blood glucose
- GI x carbohydrate grams/100

Low vs. High GI



What Affects a Food's GI?

Botanical	• Different Variety of Foods (Rice/Potatoes)
Processing of Food	• Instant vs. Steel-Cut Oats • More finely ground grain (Higher GI)
Fiber	• Oats, barley and legumes (Lower GI)
Preparation of Food	• *Al dente* vs Fully Cooked pasta
External Factors	• Prior food intake • Blood glucose level at the time of meal • Exercise

GI and GL Ranges

Glycemic Index	• Low GI= ≤55 • Moderate GI= 56-69 • High GI= 70+
Glycemic Load	• Low GL= ≤10 • Moderate GL=11-19 • High GL=20+

How to Calculate GL

Glycemic Load = (Glycemic Index X grams of carbohydrate) ÷ 100

GI
- Watermelon GI: 72

Carbohydrate
- 1 ¼ cup: 14 g

Calculate GL
- 14 g carb x 72 (GI) = 1,008
- 1,008÷100= 10 (GL)

Take Home Message
- Watermelon has a HIGH GI but a LOW GL depending on portion size

Food Values: Glycemic Index/Glycemic Load

	Low GI	Med GI	High GI
Low GL	All-bran cereal (8,42) Apples (6,38) Carrots (3,47) Peanuts (1,14) Strawberries (1,40) Sweet Corn (9,54)	Beets (5,64) Cantaloupe (4,65) Pineapple (7,59) Sucrose, i.e. table sugar (7,68)	Popcorn (8,72) Watermelon (4,72) Whole wheat flour bread (9,71)
Med GL	Apple juice (11,40) Bananas (12,52) Fettucine (18,40) Orange juice (12,50) Sourdough wheat bread (15,54)	Life Cereal (16,66) New potatoes (12,57) Wild rice (18,57)	Cheerios (15,74) Shredded wheat (15,75)
High GL	Linguine (23,52) Macaroni (23,47) Spaghetti (20,42)	Couscous (23,65) White rice (23,64)	Baked Russet potatoes (26,85) Cornflakes (21,81)

Source: Revised International Table of Glycemic Index (GI) and Glycemic Load (GL). *The American Journal of Clinical Nutrition*, July 2002

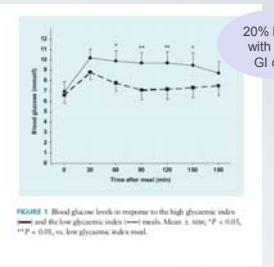
Low GI diet in children with T1DM

- Improved diet quality
  - Fiber increased: 24.5 vs. 14.5 g
  - Decreased fat: 45.7 vs. 76.9 g
- Decreased daytime hyperglycemia
- Small study-short duration
- Unrealistic foods?

The Effect of a Low-Glycemic Diet vs. a Standard Diet on Blood Glucose Levels and Macronutrient Intake in Children with Type 1 Diabetes (Journal of American Dietetic Assoc. 2009;109:303-307)

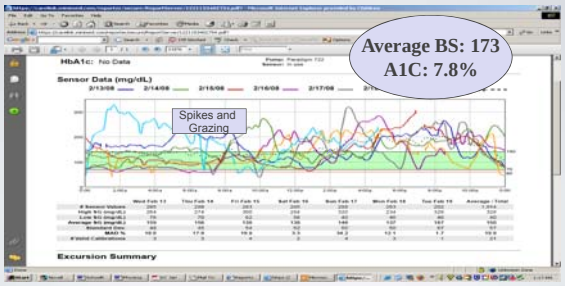
Study in Adults with Type 1 DM

- Fat, Carbs, Fiber and Calories were similar
- Low GI Diet: 59
  - Legumes, pasta, olive oil, apple, tunafish
- High GI Diet: 90
  - Rice, tunafish, white bread, olive oil, banana



Effects of meals with different glycaemic index on postprandial blood glucose response in patients with Type 1 diabetes treated with continuous subcutaneous insulin infusion (Diabetic Medicine. 2001. 28, 227-229)

High GI: Low fiber diet



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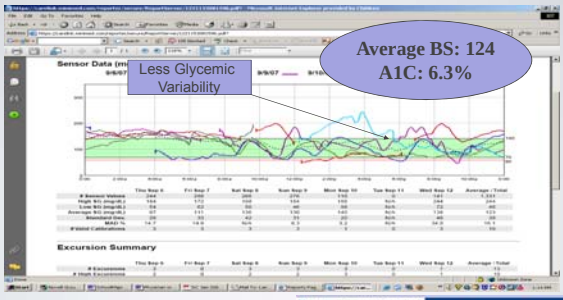
Lower GI Diet: High fiber diet



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Medium GL… but is it healthy?

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Pros and Cons of GI

Pros

- Minimizes blood glucose peak
- Increases dietary fiber intake if choosing more whole grains
- May improve lipid levels if high fiber, low GI foods are eaten

Cons

- Not accurate when eating a mixed meal
- Unreliable (variable responses among test subjects)
- Limited food choices
- May increase fat intake
- No long term studies in children with TIDM

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When should your patient eat high GI foods?

Sports

- To increase BG levels quickly
- Sports drinks, gels and carb chews

Hypoglycemia

- Protein and fat with carbs delays high BG
- 100% glucose best choice to raise BG quickly

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Substituting High GI for Low GI

High GI Food	Low GI Food
White bread	Whole grain bread
Puffed and flaked breakfast cereals	Whole grain cereals (steal-cut oats)
Plain crackers	Whole grain crackers
White Potatoes	Sweet potatoes
White Rice	Basmati rice, quinoa, whole grain pasta

How to Lower Glycemic Variablilty…

- Check blood glucose 3 hours after meals-look for patterns
- Eat more dietary fiber
- Consider GI and/or GL
- Bolus Insulin before meals/snacks
  Consider dual-wave bolus for low GI foods
- Eat lower fat

What Does this ALL Mean?

Try eating more Low GI Foods	• Most fruits and vegetables • Whole grains • Legumes
Added Sugars in Moderation	• Eat foods high in sugar in moderation • Don't completely avoid sugar to prevent over eating • Eat in smaller portions
Don't forget about the Quantity	• Don't carb restrict to control glucose levels • About half of your calories should come from carbs
Accurate Carb Counting	• Unexplained highs?- measure carbs • Try Carbohydrate Factors, carb apps, books/websites

MNT delivered by a registered dietitian is associated with A1C decreases of 0.3–1% for people with type 1 diabetes and 0.5–2% for people with type 2 diabetes.