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Medical Nutrition Therapy for Glycemic Control

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Disclosures

I have no relevant relationships with ineligible companies to disclose within the past 24 months.

Educational Objectives

At the conclusion of this session, participants should be able to:

- Cite the benefits and goals of nutrition therapy for adults with diabetes.
- Empower patients to make appropriate food choices to improve glycemic control by learning to carbohydrate count.
- Calculate a carbohydrate-to-insulin ratio.
- Estimate insulin sensitivity factors.
- Determine when it is necessary to refer a patient for nutrition therapy, diabetes education and support.

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"What can I eat?"

For many people with diabetes (PWD), the most challenging part of their treatment plan is determining what to eat.

Unfortunately, national data indicate that most PWD do not receive any nutrition therapy or formal diabetes education.

Medical Nutrition Therapy (MNT)

The National Academy of Medicine broadly defines medical nutrition therapy as:

- The treatment of a disease or condition through the modification of nutrient or whole-food intake.
- Typically provided by a registered dietitian nutritionist (RD/RDN).

MNT for Diabetes Mellitus (DM)

- There is not a “one-size-fits-all ”meal pattern for PWD.
- Meal planning should be individualized.
- Because T2DM is a progressive disease, behavior modification alone is not adequate to maintain euglycemia over time.
- RDNs providing MNT should assess and monitor medication changes in relation to the nutrition care plan.
- The RDN should be knowledgeable and skilled in providing DM-specific MNT, preferably a certified diabetes educator (CDE) or board certified in advanced diabetes management (BC-ADM).

Goals of MNT for Adults with Diabetes

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

- achieve and maintain body weight goals
- attain individualized **glycemic targets** and blood pressure and lipid goals
- delay or prevent the complications of DM

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 existing barriers to change.

3. To maintain the pleasure of eating by providing nonjudgmental messages about food choices while limiting food choices only when indicated by scientific evidence.

4. To provide practical tools for developing healthy eating patterns rather than focusing on individual macronutrients, micronutrients, or single foods.

Eating Patterns

- A variety of eating patterns are appropriate for the management of DM; as the evidence is limited, it is unclear which, if any, are optimal.
- Key factors common among health-promoting eating patterns:
  - **Emphasize non-starchy vegetables.**
  - **Minimize added sugars and refined grains.**
  - **Choose whole foods over highly processed foods to the extent possible.**
- Reducing overall carbohydrate (CHO) for PWD has demonstrated improving glycemia.
- Those with TY2DM not meeting glycemic targets or where reducing meds is a priority, low/very low-CHO eating plans are a viable approach.
- An energy deficit, regardless of macronutrient composition, will result in weight loss.
- PWD requiring insulin should receive education on how to match mealtime doses to CHO, fat and protein intake and anticipated physical activity (PA).

Macronutrients

- An ideal percentage of calories from CHO, protein, and fat has not been established for those with or at risk for DM.
- A key strategy to achieve glycemic targets should include an assessment of current dietary intake followed by individualized guidance on monitoring CHO intake and blood glucose (BG) to optimize meal timing and food choices and to guide medication and PA recommendations.
- PWD and those at risk for DM are encouraged to consume a minimum of 14 grams of fiber/1,000 kcal daily, with at least half of grain consumption being whole or intact grains.

Glycemic Targets

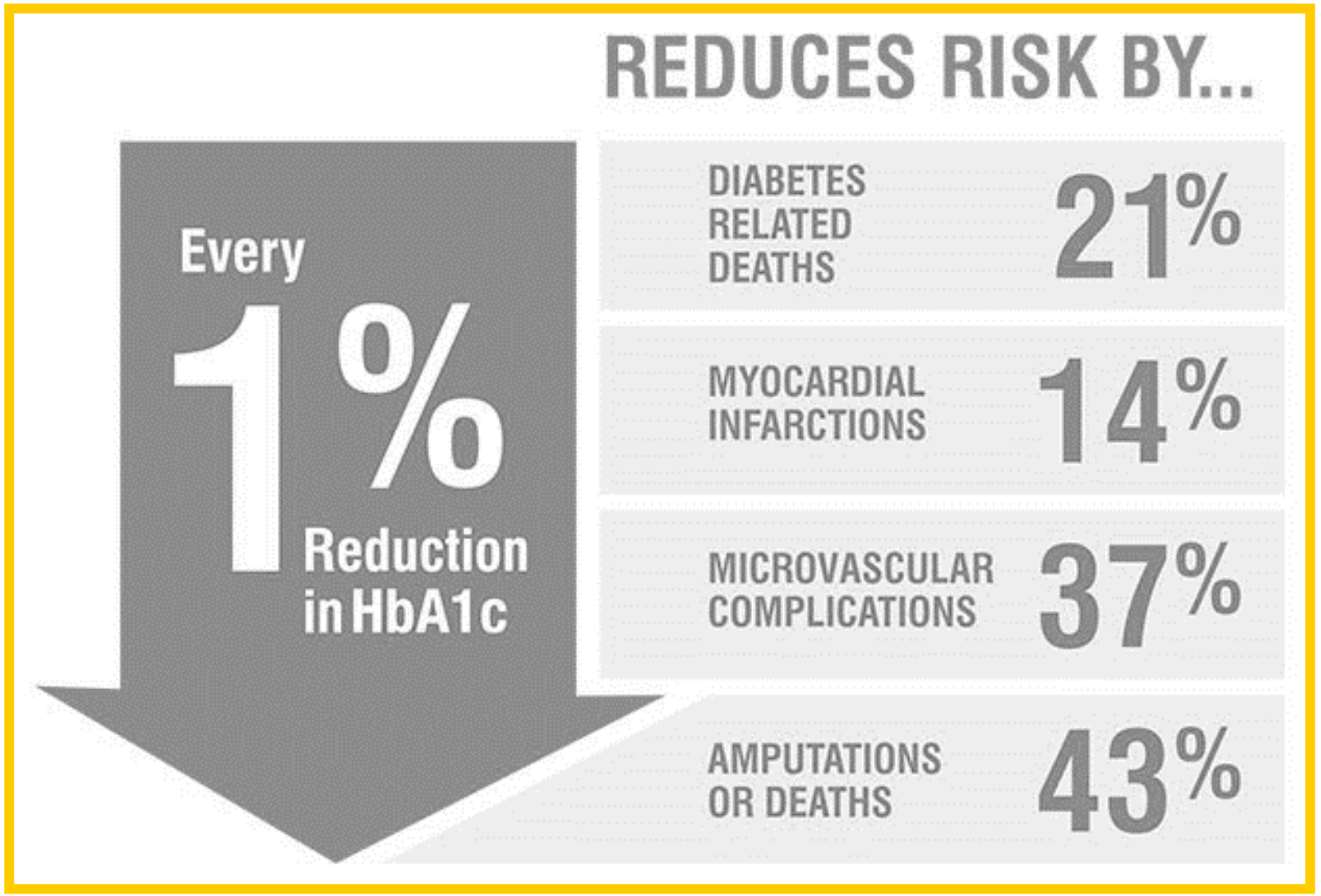
American Association of Clinical Endocrinologists (AACE)

- A1c ≤6.5% (less stringent for “less healthy”)
- FBS 70–110 mg/dl
- 2 hours after meals <140 mg/dl

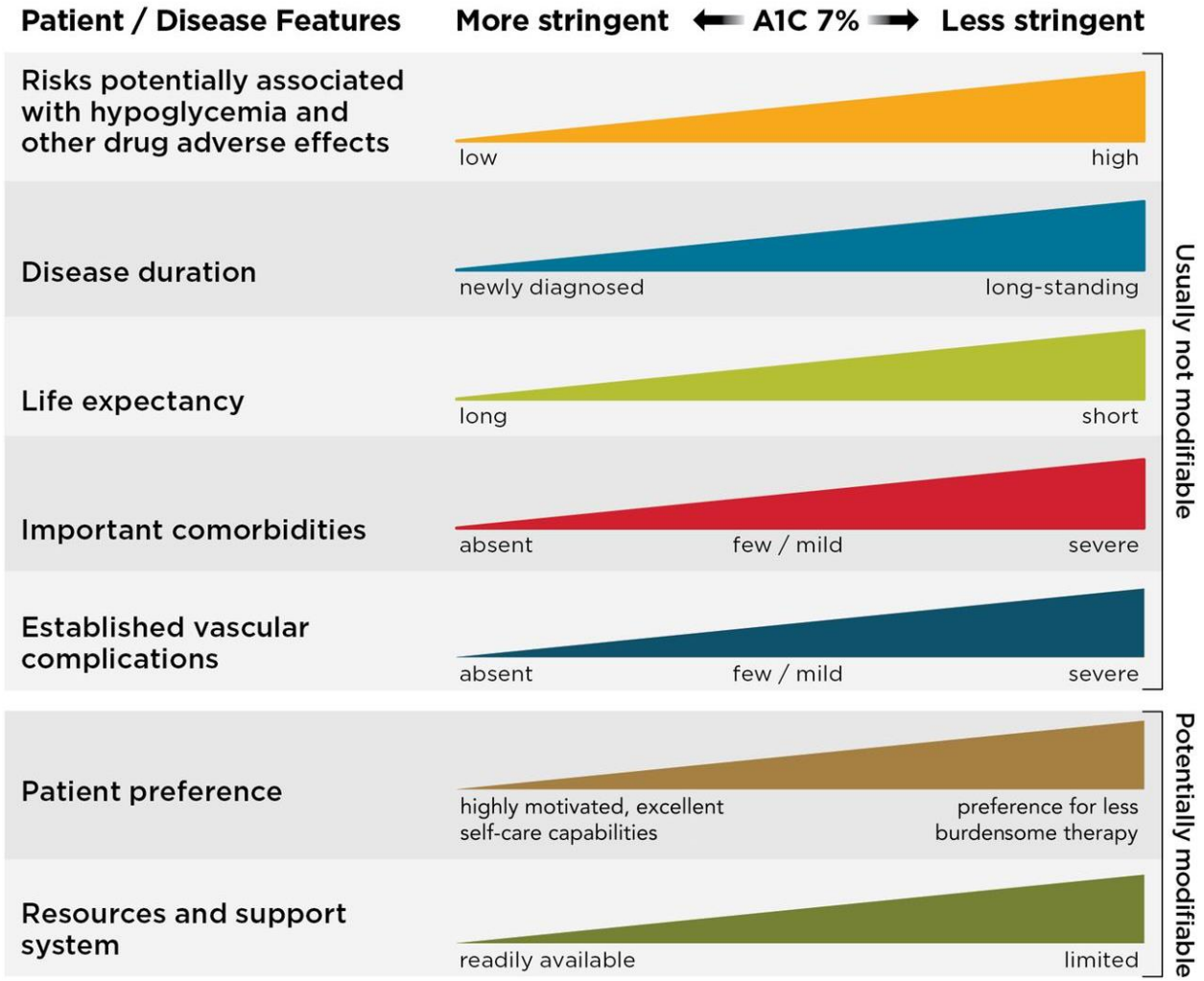
American Diabetes Association (ADA)

- A1c <7.0% (more stringent for some)
- FBS 80–130 mg/dl
- Peak postprandial <180 mg/dl

The Diabetes Control and Complications Trial



ADA's Guidelines for Individualization of Glycemic Targets



Glycemic Targets: ADA Standards of Medical Care in Diabetes—2022.

Use of Empowering Language

The ADA lists five key recommendations. Use language that:

1. Is neutral, nonjudgmental, and based on facts, actions, or physiology/biology;
2. Is free from stigma;
3. Is strength-based, respectful, and inclusive and that imparts hope;
4. Fosters collaboration between patients and providers;
5. Is person centered ("person with diabetes" is preferred over "diabetic").

Facilitating Behavior Change & Well-being to Improve Health Outcomes ADA Standards of Medical Care in Diabetes—2022

More Importantly – Empower Your Patients

- Don’t tell PWD what to eat; teach them how to discover for themselves what is best for them to eat.
- Providing the necessary skills will empower your patients with the ability to make behavior changes to achieve glycemic control and optimal health.
- Carbohydrate counting (CC) is an effective meal-planning method which empowers patients by:
  - **allowing freedom of food choices**
  - **permitting greater mealtime flexibility**
  - **encouraging autonomy**

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Carbohydrate Counting

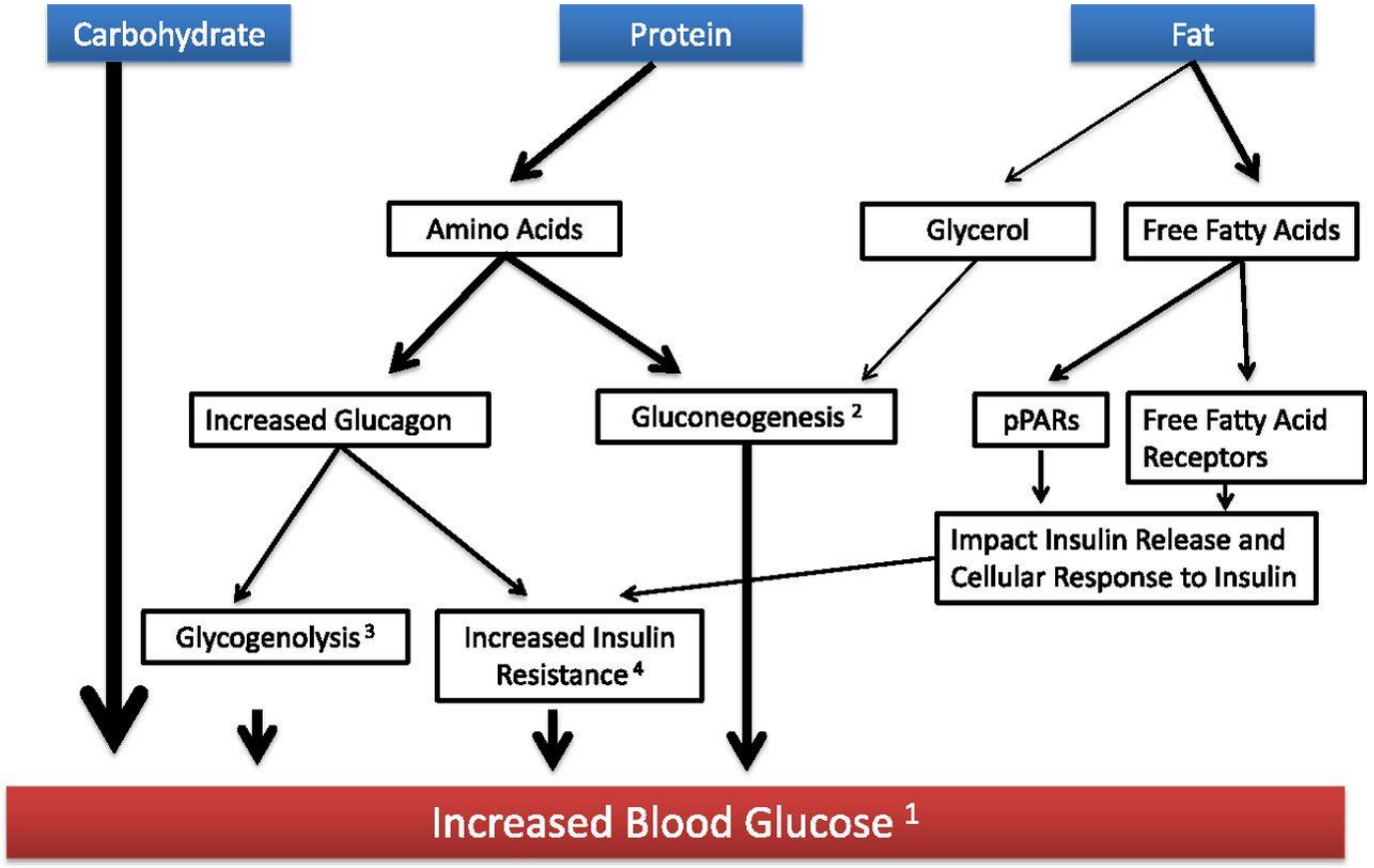
Basic

Basic CC is a structured approach that emphasizes consistency in the timing of meals and CHO consumed. Patients are taught the relationship among food, medications, PA, and BG levels. Basic CHO counting assigns a fixed amount of CHO to be consumed at each meal and, if necessary, snacks. PWD must learn how to identify CHO foods, recognize serving sizes, read food labels and weigh and measure foods accurately.

Advanced

Instead of being based on a structured approach, advanced CC involves matching the amount of CHO consumed with an appropriate bolus dose of insulin. The amount and type of CHO can vary, allowing freedom of food choices; but, with this freedom comes responsibility, and PWD who are taught advanced CC also should be taught good nutrition and calorie consciousness to avoid weight gain and chronic disease.

Mechanisms by Which CHO, Protein and Fat Contribute to Increasing BG Levels and Insulin Requirements in T1DM



Points of insulin requirement:

1 - insulin is required to metabolize glucose;

2 - insulin is required to stop gluconeogenesis;

3 - insulin is required to stop conversion of glycogen to glucose;

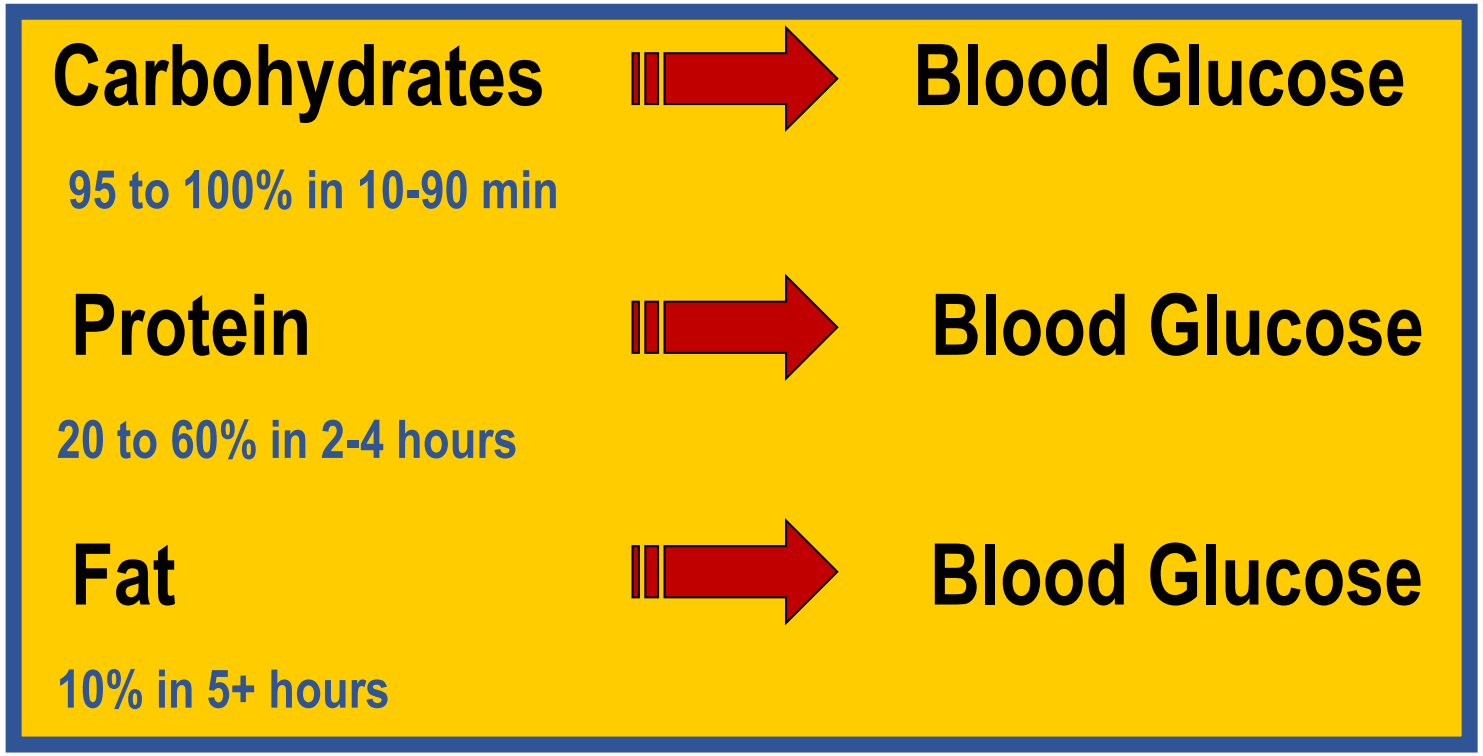
4 - insulin is required to counteract insulin resistance.

Width of arrows indicates relative contribution to increase in BG.

pPARs - peroxisome proliferator–activated receptors.

Carmel E.M. Smart, Bruce R. King, Prudence E. Lopez; Insulin Dosing for Fat and Protein: Is it Time?. Diabetes Care 1 January 2020; 43 (1): 13–15. https://doi.org/10.2337/dci19-0039

Macronutrient Effect on Post-Meal Blood Glucose



Basic Carbohydrate Counting: No Insulin or Fixed Insulin

Offers little flexibility as patient must:

- eat at similar times each day
- eat similar amounts of food at each meal
- consume a consistent CHO intake to match insulin or oral meds
- be aware of variations in PA; as more likely to cause high or low BG

Benefits include:

- simplicity
- a variety of CHO-containing foods can be consumed

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Basic Carbohydrate Counting: No Insulin or Fixed Insulin

2 cups cereal

1 banana

8 ounces milk

Blood Sugar: 210 mg/dl

3 eggs

4 slice bacon

1 slice cheese

1 slice bread

1 banana

Blood Sugar: 140 mg/dl

2 cups cereal

8 ounces milk

Blood Sugar: 170 mg/dl

2 cups cereal	50 g
1 banana	25 g
8 oz milk	12 g
	87 g

Blood Sugar: 210 mg/dl

2 cups cereal	50 g
8 oz milk	12 g
	62 g

Blood Sugar: 170 mg/dl

3 eggs	0 g
4 sllice bacon	0 g
1 slice cheese	0 g
1 slice bread	15 g
1 banana	25 g
	40 g

Blood Sugar: 140 mg/dl

The amount, rather than the type, of CHO has the most significant effect on BG levels after a meal.

Advanced Carbohydrate Counting: Basic Insulin Review

- The general calculation for a daily insulin requirement is:

0.55 X total weight (kg) = Total Daily Dose (TDD)

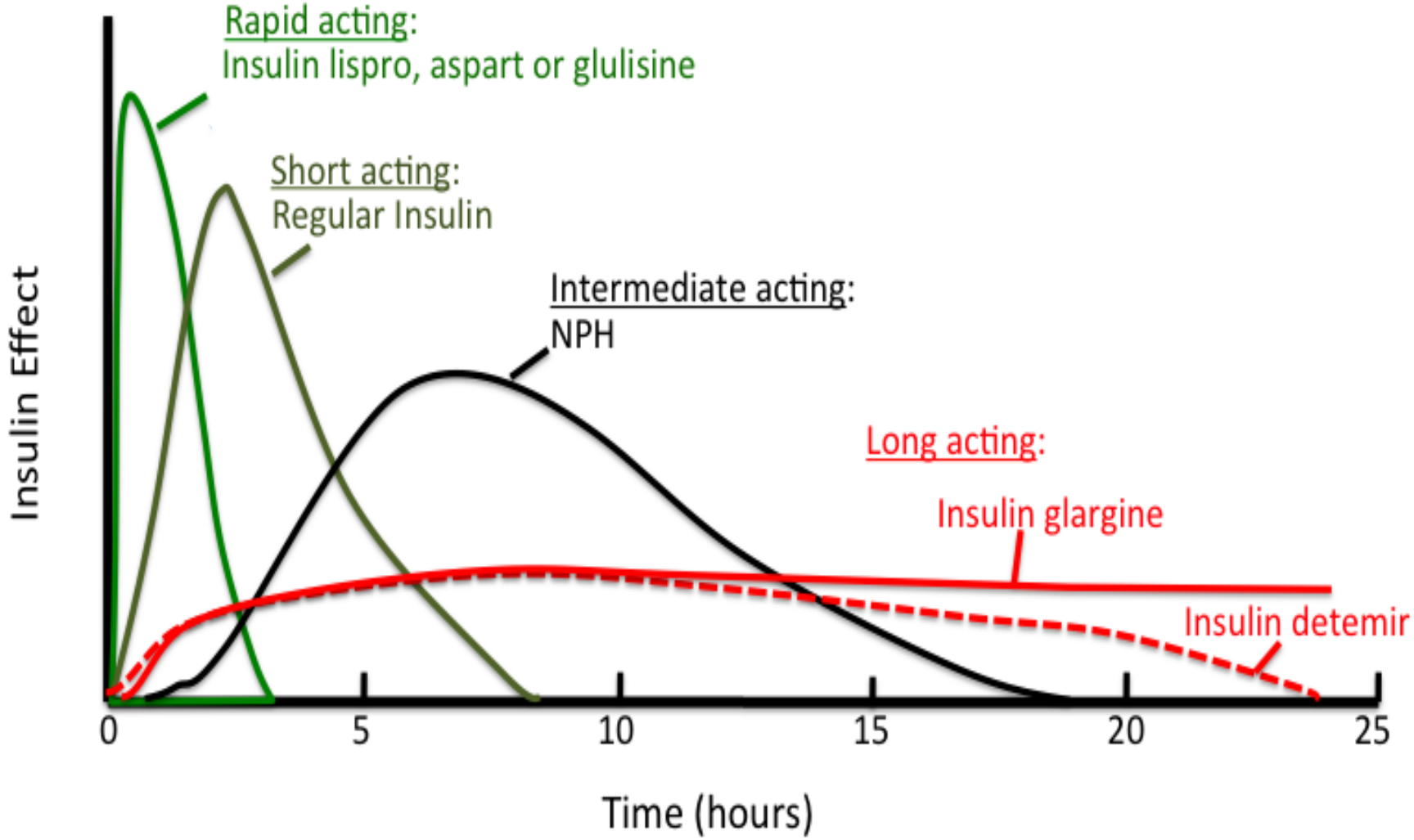
Example: TDD for a 70 kg women = 0.55 x 70 Kg = 38.5 units/day

(More/less may be required based on individual sensitivity/production.)

- Approximately 40-50% of the TDD is a basal insulin and is usually constant from day-to-day.
- The other 50-60% of the TDD is the bolus dose; for food coverage (primarily CHO) and hyperglycemia corrections.

Insulin	Brand/Generic	Onset	Peak	Duration
Rapid-Acting	Apidra (glulisine) Humalog (lispro) Novolog (aspart)	15 minutes	1 or 2 hours	2 to 4 hours
Regular- or Short-Acting	Humulin R, Novolin R (human recombinant)	30 minutes	2 to 3 hours	3 to 6 hours
Intermediate-Acting	Humulin N, Novolin N (NPH)	2 to 4 hours	4 to 12 hours	12 to 18 hours
Long-Acting or Basal Insulin	Lantus, Semglee (glargine) Levemir (detemir)	2 to 4 hours	low peak	24 hours
Ultra Long-Acting	Toujeo (glargine u-300) Tresiba (degludec)	6 hours	small peak	36-42 hours
Inhaled Insulin	Afrezza (insulin human)	15 minutes	30 minutes	3 hours

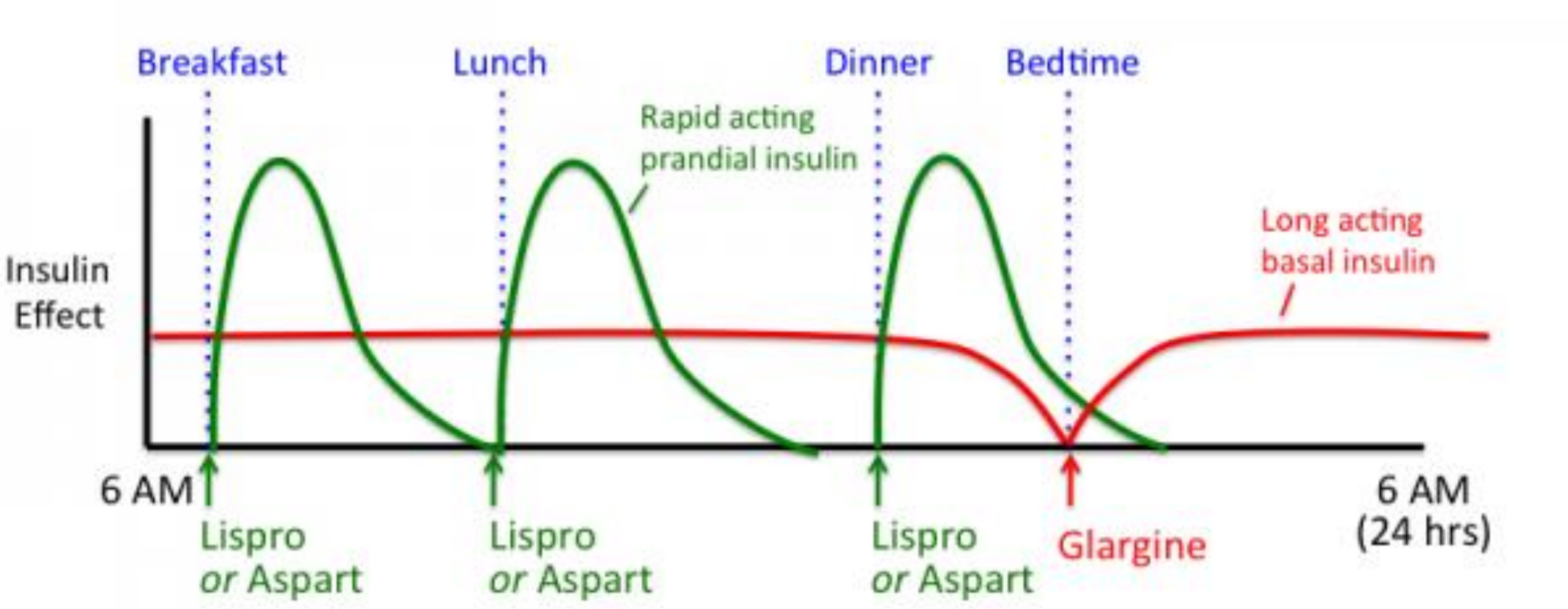
Insulin: Onset, Peak & Duration



Bolus – Carbohydrate Coverage

- When CC the bolus dose is prescribed as an insulin-to-CHO ratio (IRC).
- The ICR represents how many grams of CHO are covered or disposed of by 1 unit of insulin.
- Generally, 1 unit of rapid-acting insulin will dispose of 12-15 grams of CHO.
- This range can vary from 6-30 grams or more of CHO depending on an individual's sensitivity to insulin, which can vary according to the time of day, from person to person, PA and stress.

Multiple Insulin Injections (MII)



Advanced Carbohydrate Counting: Adjusting Mealtime Insulin Doses

In flexible insulin therapy (MII), each bolus dose has two components:

1. A ‘food dose’ that covers the CHO content of that meal.

2. A “correction dose” that considers pre-meal BG level and planed after the meal activity.

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Step 1: Cover the Carbohydrates

- In order to cover the total grams of CHO in a meal the patient's ICR must be determined. This ratio may be 1:15 for someone who is very sensitive to insulin or only 1:5 for someone who is less sensitive.
- A ratio of 1:10 indicates that for every 10 grams of CHO consumed, 1 unit of rapid-acting insulin is required.
- ICRs can be determined by reviewing food records which include accurate recording of CHO intake and pre/post-meal BG levels.
- Alternately, a starting ratio can be estimated based on a person's weight (i.e., 100 to 120 lbs.-1:18; 230 to 270 lbs.-1:6) or a standard calculation ("500 Rule").

Determining ICR Using Patient Records

Patient's Log:

Pre-meal BG: 105 mg/dl
Pre-meal insulin dose: 5 units of Humalog
CHO consumed: 55 grams
2-hour post-meal BG: 138 mg/dl

- The correct amount of insulin was administered as evidence by a post-meal excursion of less than 40 mg/dl; so, we can determine that the ICR is 1:11 (55/5 = 11).
- Using this ICR, if the patient plans to consume 23 grams of CHO, they would require 2 units of insulin to cover the meal (23/11= 2.1).
- The effectiveness of insulin dosing decisions should be confirmed with a structured approach to BGM or CGM to evaluate individual responses and guide insulin dose adjustments.

Determining ICR Using The “500 Rule”

- A starting ICR can also be estimated using the “500 Rule”.
- Divide 500 by the TDD of insulin.
- The result is CHO grams that are covered by approximately 1 unit of rapid acting insulin.
- The ratio is fine-tuned over time by analyzing the patient’s BG logs before and after meals.

Example: If patient is currently injecting 15 units long-acting insulin and 25 units rapid-acting insulin daily, the starting ICR is 1:12.5

TDD: 15+25 = 40 500/40 = 12.5

Give It a Try

Jack is planning to have 2 cups of macaroni and cheese for lunch. He reads the nutrition label to determine grams of CHO to calculate his insulin dose. His pre-meal BG is within his target range and his ICR is 12.

How much bolus insulin should Jack take?

a. 4 units
b. 5 units
c. 8 units
d. 12 units

Nutrition Facts

3 servings per container

Serving size **⅓ container (100g) (makes about 1 cup)**

	Per serving		Per container	
Calories	**290**		**880**	
		%DV*		**%DV***
Total Fat	9g	**12%**	28g	**36%**
Sat. fat	3.5g	**18%**	11g	**55%**
Trans Fat	0g		0g	
Cholest.	0mg	**0%**	0mg	**0%**
Sodium	670mg	**29%**	2020mg	**88%**
Total Carb.	49g	**18%**	146g	**53%**
Fiber	2g	**7%**	5g	**18%**
Total Sugars	1g		3g	
Incl. Added Sugars	0g	**0%**	1g	**2%**
Protein	4g		12g	
Vitamin D	0mcg	0%	0mcg	0%
Calcium	205mg	15%	615mg	45%
Iron	1mg	6%	3mg	15%
Potassium	98mg	2%	294mg	6%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

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Question 1

Jack is planning to have 2 cups of macaroni and cheese for lunch. He reads the label to determine grams of CHO to calculate his insulin dose. His pre-meal BG is within his target range and his ICR is 12.

How much bolus insulin should Jack take?

a. 4 units
b. 5 units
c. 8 units
d. 12 units

Answer Question 1

Jack is planning to have 2 cups of macaroni and cheese for lunch. He reads the nutrition label to determine grams of CHO to calculate his insulin dose. His pre-meal BG is within his target range and his ICR is 12.

How much bolus insulin should Jack take?

Answer: 49x2/12 = 8 units

Nutrition Facts

3 servings per container

Serving size ~~½ container (100g)~~ **(makes about 1 cup)**

	Per serving		Per container	
Calories	**290**		**880**	
		%DV*		**%DV***
Total Fat	9g	**12%**	28g	**36%**
Sat. fat	3.5g	**18%**	11g	**55%**
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*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

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Advanced Considerations: Fiber & Sugar Alcohols

- If a food has ≥5 grams of fiber, subtract half the amount of fiber from the total CHO grams.
- Also adjust for sugar alcohols if there are ≥5 grams in the meal. Again, subtract half the amount from the total CHO grams.
- This should be considered a need-to-know tool that can be taught to patients who may benefit from using it based on their eating patterns and BG data.

Example: A food that has 30 grams of CHO and either 8 grams of fiber or sorbitol would be counted as 26 grams of CHO:

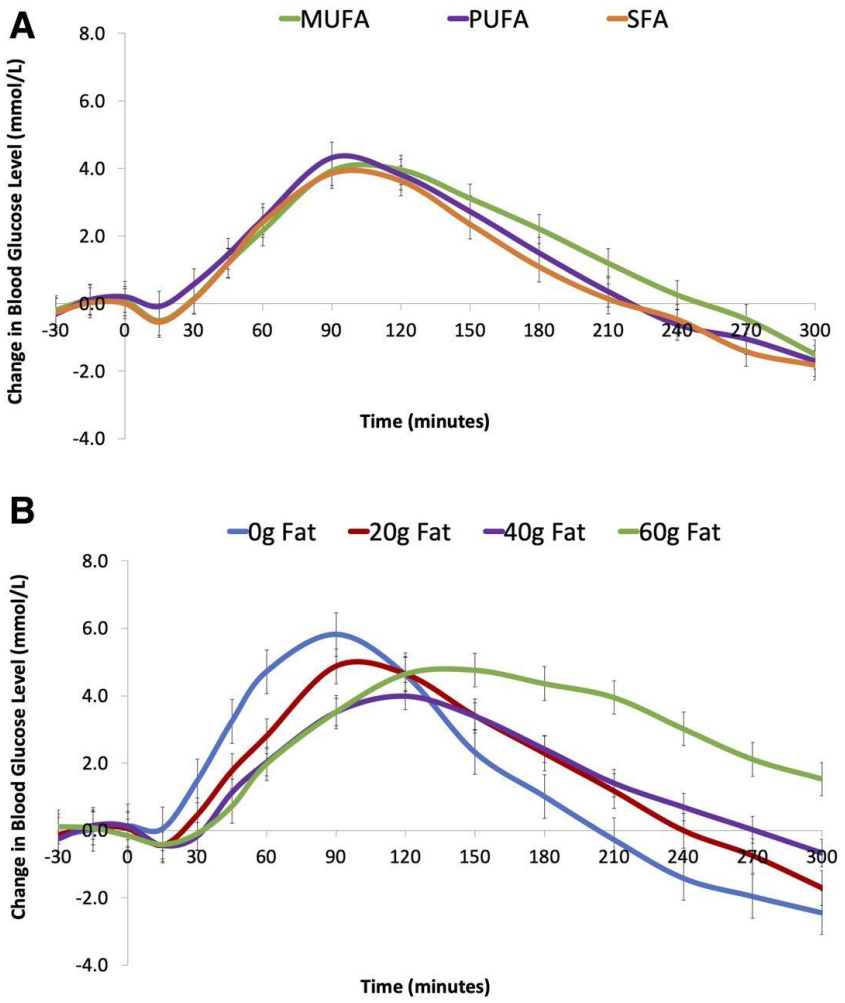
30-4=26

Advanced Considerations: Protein & Fat

For more precise insulin dosing the amount of protein and fat may also need to be considered; although, more research needs to be done to determine a useful algorithm as studies point to individual differences in postprandial glycemic response of mixed meals. We do know:

- Protein influences postprandial glycemia, this effect is likely delayed by approximately 1.5 hours.
- High fat meals such as pizza or fast food can cause prolonged hyper-glycemia 3-5 hours after eating.
- A cautious approach to increasing insulin doses for high-fat and/or high-protein mixed meals is recommended to address delayed hyperglycemia.
- If using an insulin pump, a split bolus feature (part of the bolus delivered immediately, the remainder over a programmed duration of time) may provide better insulin coverage for high-fat and/or high-protein mixed meals.

Amount and Type of Dietary Fat, Postprandial Glycemia, and Insulin Requirements in Type 1 Diabetes: A Randomized Within-Subject Trial



Postprandial glucose profiles for varying types (A) (n = 16) and amounts (B) (n = 15) of fat in T1D using insulin pump therapy according to individualized ICR as dual-wave 50/50% over 2 h.

Bell KJ, 2020

Keep In Mind

- Frequent BGM and record keeping are required initially; so, success depends on patient motivation and education provided.
- BG levels, pre-meal and 2-hours following a meal, are needed to assess the accuracy of the ICR.
- Generally, the target is a BG increase of about 40 mg/dl 2-hours post-prandially.
- When the ICR is determined to be correct, post-meal BG readings can then be taken less often.
- The ICR ratio may be different at different times during the day.
- Inappropriate calorie intake is a potential negative consequence.

Step 2: Add or Subtract a Correction Dose of Insulin Based on Pre-Meal BG Level

- First determine the insulin sensitivity factor (ISF), sometimes called a “correction factor”.
- The ISF is simply a measure of the impact that insulin has on the patient; the amount by which BG is reduced by one unit of rapid-acting insulin in a period of 2-4 hours.
- Generally, one unit of rapid insulin is needed to drop BG by 50 mg/dl.
- However, this drop in BG can range from 30-100 mg/dl, depending on individual insulin sensitivities, and other circumstances.

Calculating The Insulin Sensitivity Factor

- The standard “1700/1800 Rules” are used to calculate an ISF.
- This calculation estimates the point drop in mg/dL for every unit of bolus insulin taken: The calculation is based on the TDD.
- For rapid-acting insulin, TDD is divided by 1700.
  - **1700/TDD = ISF**
- For short-acting insulin, TDD is divided by 1800.
  - **1800/TDD = ISF**

Example: For a person taking 55 units of rapid-acting + long-acting insulin daily the ISF is 31:

1700/55 = 31

Calculating A Correction Bolus Dose

- If premeal BG is out of the targeted range (high/low), the bolus dose will need to be adjusted accordingly.
- Subtract target BG from current BG.
- Divide the difference by the ISF.
- The result is the correction dose of insulin; the units needed to be either added or subtracted from meal coverage dose.

Example: FBS is 190 mg/dl, target FBS is 100 mg/dl, ISF is 30

190 – 100 = 90 90/30 = 3

3 additional units of rapid-acting insulin required

Question 2

How much Humalog insulin would a patient need to administer if their:

- pre-meal BG is 109 mg/dl
- ISF is 48
- ICR is 1:15
- meal contains 60 grams of CHO?

a. 2 units
b. 4 units
c. 6 units
d. 8 units

Answer Question 2

How much Humalog insulin would a patient need to administer if their:

- pre-meal BG is 109 mg/dl
- ISF is 48
- ICR is 1:15
- meal contains 60 grams of CHO?

4 units to cover 60 grams of CHO: 60/15=4

No additional insulin for correction is need because pre-meal BG is within target range.

Question 3

How much rapid-acting insulin would a patient need to administer if their:
- pre-meal BG is 200 mg/dl
- ISF is 45
- ICR is 1:12
- meal contains 48 grams of CHO?

a. 3 units
b. 4 units
c. 5 units
d. 6 units
e. 7 units

Answer Question 3

How much rapid-acting insulin would a patient need to administer if their:

- pre-meal BG is 200 mg/dl
- ISF is 45
- ICR is 1:12
- meal contains 48 grams of CHO?

4 units to cover 48 grams of CHO: 48/12=4

Plus 2 units to correct pre-meal hyperglycemia: 200-110=90 90/45=2

Total 6 units required.

Question 4

How much bolus insulin would a patient need to administer if their:

- pre-meal BG is 68 mg/dl
- ISF is 40
- ICR is 1:10
- meal contains 30 grams of CHO?

a. 0 units
b. 1 units
c. 2 units
d. 3 units

Answer Question 4

How much bolus insulin would a patient need to administer if their:

- pre-meal BG is 68 mg/dl (no hypoglycemia symptoms)
- ISF is 40
- ICR is 1:10
- meal contains 30 grams of CHO?

3 units to cover meal: 30/10=3

Less 1 unit to correct pre-meal below target: 68-110=(42) 42/40=1

Total 2 units required; would advise patient to take insulin after meal.

CHO Adjustment During Physical Activity

- Variable glycemic responses to PA make uniform recommendations for food and insulin dosing difficult.
- To prevent hypoglycemia during prolonged (≥30 min), predominantly aerobic exercise, additional CHO intake and/or reductions in insulin are typically required.
- For low to moderate-intensity aerobic activities lasting 30-60 min undertaken when circulating insulin levels are low (fasting or basal conditions), ~10-15 grams of CHO may prevent hypoglycemia.
- For activities with relative hyperinsulinemia (after bolus), 30-60 grams of CHO/hour of exercise may be needed.

Insulin Adjustment During Physical Activity

- Lowering insulin levels during activity may reduce or eliminate the need for added CHO.
- A 20% reduction in basal insulin for individuals on MDII can be made for doses both before and/or after exercise.
- Pump users can reduce or suspend insulin delivery at the start of exercise or reduce basal rate 30-60 min before exercise.
- Frequent BGM or CGM is required for insulin and CHO adjustments.

Education & Support

- Building positive health behaviors and maintaining psychological well-being are foundational for achieving DM treatment goals and maximizing quality of life.
- Essential to achieving these goals are diabetes self-management education and support (DSMES), MNT, routine PA, smoking cessation counseling when needed, and psychosocial care.
- In accordance with the national standards for DSMES, all PWD should participate in DSME and receive the support needed to facilitate the knowledge, decision-making, and skills mastery for DM self-care.

MNT Improves Outcomes

- Strong evidence supports the effectiveness of MNT provided by RDNs for A1C decreases up to 2.0% (T2DM) and up to 1.9% (T1DM) at 3–6 months.
- Reported A1C reductions from MNT can be similar to or greater than what is expected with current pharmacological treatments.
- Ongoing MNT is helpful in maintaining glycemic improvements.

DSMES Improves Outcomes

- According to the National Standards for DSMES, at least one instructor responsible for designing and planning DSMES must be a nurse, dietitian, or credentialed health professional (CDE, BC-ADM).
- DSMES should be patient centered, may be offered in group or individual settings, and should be communicated with the entire diabetes care team.
- DSMES has been shown to be cost-effective by reducing hospital admissions and readmissions, as well as lower lifetime health care costs related to a decreased risk for complications.

Barriers to MNT and DSMES

Low participation often due to:

- lack of referral
- logistical issues (accessibility, timing)
- limited reimbursement rates
- lack of a perceived benefit

Evidence indicates that some barriers to access may be mitigated through telemedicine approaches.

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MNT Referrals for PWD

- **Academy of Nutrition and Dietetics:** The RDN should implement 3-6 MNT encounters during the first 6 months following dx; additional encounters as needed. The RDN should implement a minimum of one annual MNT follow-up encounter.
- **American Diabetes Association:** All providers should refer PWD for individualized MNT provided by an RDN who is knowledgeable and skilled in providing DM-specific MNT at dx and as needed throughout the life span.
- **The National Academy of Medicine:** Recommends individualized MNT, provided by an RDN upon physician referral, as part of the multidisciplinary approach to DM care.

Referrals for DSMES

Four critical time points have been defined when the need for DSMES is to be evaluated by the medical care provider.

1. At diagnosis
2. Annually and/or when not meeting treatment targets
3. When complicating factors (health conditions, physical limitations, emotional factors, or basic living needs) develop that influence self-management
4. When transitions in life and care occur

Facilitating Behavior Change & Well-being to Improve Health Outcomes
ADA Standards of Medical Care in Diabetes—2022

Take Home Points

- DM is a chronic disease that requires a PWD to make a multitude of daily self-management decisions and to perform complex care activities.
- MNT is fundamental in the overall management of DM and eating plans should be developed in collaboration with the PWD.
- CHO counting, both basic and advanced, are excellent options to provide those with TY1 and TY2 DM the freedom to make choices about their food intake while maintaining glycemic control.
- All providers should refer PWD for individualized MNT and to DSMES programs to improve outcomes.

Questions?

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