

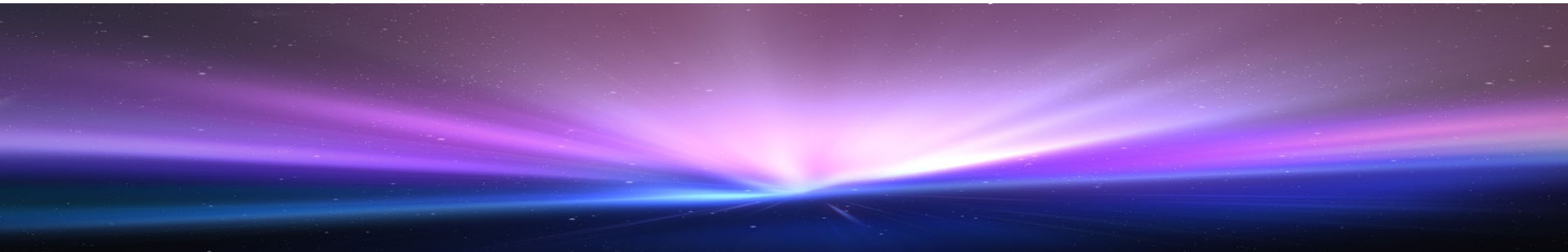
Nutrition and Type 1 Diabetes

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Today's Topics

- Nutrition as it relates to type 1 diabetes
- Carbohydrate counting basics
- Advanced principles of carb management
- Treating hypoglycemia
- Alcohol
- Exercise

What should people be eating?

There is no simple answer ...
and no single diet that is ideal for all people

Carbohydrate, protein, fat...

Numerous studies failed to find an ideal mix of macronutrients that suits everyone with DM.

Goals of Nutrition Therapy

- To promote and support healthful eating
- Nutrient dense foods; appropriate portions
- Individualized to meet:
 - Glycemic, BP, lipid, and weight goals
 - Prevent, delay, and treat complications of DM
 - With respect to personal and cultural choices

ADA Carb Advice

- For good health;
 - Carb intake from vegetables, fruits, whole grains, legumes and dairy products should be advised over intake from foods with added fats, sugars, or sodium.
 - Avoid sugar sweetened beverages

ADA = American Diabetes Association

ADA Review of Eating Patterns

- ADA says: multiple meal planning approaches can be effective for achieving metabolic goals:
 - Mediterranean
 - Vegetarian + vegan
 - DASH: dietary approach to stop hypertension
 - Lower fat
 - Lower carb

Mayo Clinic

Advice on Carbs

“Contrary to what some weight-loss diets claim, very few studies show that a diet rich in healthy carbohydrates leads to weight gain or obesity.”

The Key is:

- Emphasize fiber-rich fruits and vegetables
- Choose whole grains
- Stick to low-fat dairy products
- Include beans and legumes
- Limit added sugars

Comparing Macronutrient Targets

	IOM: 2015 Dietary Guidelines	Observed average intake for people with diabetes
Carbs	45 - 65 %	45 %
Protein	10 - 35 %	16 - 18 %
Fat	20 - 35 %	36 - 40 %

IOM: institutes of medicine

Diabetes Care, pg. S126 Jan. 2014

Calorie Level Daily	40% Carb grams	45% Carb grams	50% Carb grams	55% Carb grams
1200	130	135	150	165
1300	130	146	163	179
1400	140	158	175	193
1500	150	169	188	206
1600	160	180	200	220
1700	170	191	213	234
1800	180	203	225	248
1900	190	214	238	261
2000	200	225	250	275
2100	210	236	263	289
2200	220	248	275	303
2300	230	259	288	316
2400	240	270	300	330
2500	250	281	313	344
2600	260	293	325	358
2700	270	304	338	371
2800	280	315	350	385
2900	290	326	363	399
3000	300	338	375	413

Table for Estimating Daily Carb Targets

Grams of carb per day at:

40, 45, 50 or 55%
of estimated daily calories.

Note:
Dietary Reference Intake
Set by Academy of Science
National Institutes of Health
is minimum 130 g carb/d

Examples of Carb Distribution

- Women
 - Calorie controlled diets 30 - 60 g/meal
 - Maintenance levels 45 - 75 g/meal
 - Active exercisers 60 - 90 g/meal
- Men
 - Calorie controlled diets 45 - 75 g/meal
 - Maintenance levels 60 - 90 g/meal
 - Active exercisers 75 -105 g/meal
- Consistency is very important if using sliding scale insulin.
- If using insulin to carb ratios, then person has more flexibility.

Individual carb requirements vary and can be calculated with respect to: gender, age, height, weight status, activity...

Carbohydrate Foods

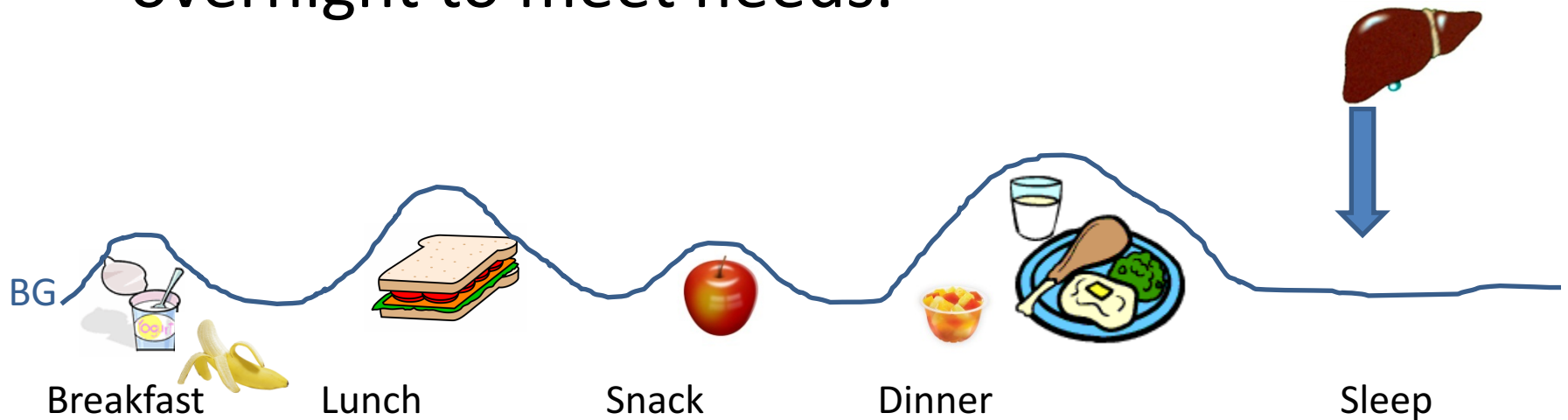
Carbohydrate intake, both type and amount, affects BG levels.

Carbohydrate foods digest → monosaccharides enter bloodstream



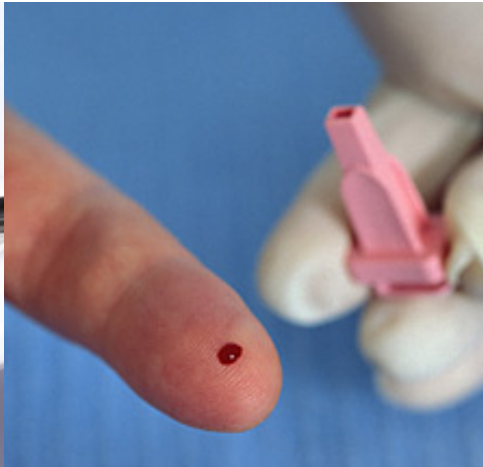
Blood Glucose

- Blood glucose levels rise after carb meals
- Some glucose is stored in liver and muscles
- Liver releases glucose between meals and overnight to meet needs.



Insulin Dosing

- Type 1 diabetes:
 - Insulin is dosed based on:
 - **Carbohydrate content of meal**
 - Current BG level
 - Level of physical activity and exercise



Insulin to Carb Ratios

- Insulin to carb ratios allows a person to:
 - adjust own insulin dose based on carb content of the meal
 - correct BG if above target range.

Example: 1:15 and 1:50 >100

Carb coverage: 1 unit rapid-acting insulin for every 15 g carb

BG correction: 1 unit rapid-acting insulin for every 50 mg/dl >100

	<u>Dose</u>
Planned meal: 90 g carb	6 units for food
Current BG: 200 mg/dl	2 units for correction
Total dose: 8 units	

Individual variation exists, this is an example only

Why not sliding scale insulin for T1DM?

Insulin dose is based only on current BG

Example of a sliding scale:

If BG is this:	Take this dose:
70 - 100 mg/dl	4 units
101 - 150 mg/dl	5 units
151 - 200 mg/dl	6 units
201 - 250 mg/dl	7 units
251 - 300 mg/dl	8 units
Over 300 mg/dl	9 units

Sliding scale dosing may be appropriate for someone with type 2 diabetes

Same dose cannot cover all meals

- Low carb meal

- Omelet: 0 carb
- Sausages: 0 carb
- Toast: 15 g carb
- Butter: 0 carb
- Coffee: 0 carb

- High carb meal

- Bagel: 60 g carb
- Banana: 30 g carb
- Juice: 30 g carb



4 units too **much** insulin?



4 units too **little** insulin?

Carb Counting Tools

- Food labels
- Food composition tables
- Carb counting books
- Cook books
- Fast food and chain restaurant brochures
- Websites
- Apps

Food Labels

See Serving Size and
grams of Total Carbohydrate

FYI:

- Fiber and sugar are included in the total carbs
- Sugar includes both added & naturally occurring.

Nutrition Facts	
Serving Size 1 cup cooked (137g)	
Servings Per Container about 2	
Amount Per Serving	
Calories 130	Calories from Fat 0
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 15mg	1%
Total Carbohydrate 30g	10%
Dietary Fiber 2g	8%
Sugars 2g	
Protein 3g	
Vitamin A 15%	Vitamin C 4%
Calcium 0%	Iron 2%

Fiber

Non-digestible

Nutrition Facts	
Serving Size 1 Tortilla (41g)	
Servings Per Container 14	
Amount per serving	
Calories 60	Calories from Fat 5
% Daily Value*	
Total Fat 0.5g	1%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 95mg	4%
Total Carbohydrate 13g	4%
Dietary Fiber 1g	4%
Sugars 0g	
Protein 1g	

Subtract fiber only if doing so will change the insulin dose calculation.

insignificant

Nutrition Facts	
Serving Size 1 Tortilla (36g)	
Servings Per Container 10	
Amount Per Serving	
Calories 50	Calories from Fat 15
% Daily Value*	
Total Fat 2g	3%
Saturated Fat 0g	0%
Trans Fat 0g	
Polyunsaturated Fat 0.5g	
Monounsaturated Fat 1g	
Cholesterol 0mg	0%
Sodium 210mg	9%
Total Carbohydrate 10g	3%
Dietary Fiber 7g	28%
Sugars 0g	
Protein 5g	

This tortilla ↑ has just 3 grams of digestible carb after subtracting the fiber.

FDA Updates Food Label

Compliance Date
7/26/18

Nutrition Facts			
Serving Size 2/3 cup (55g)			
Servings Per Container About 8			
Amount Per Serving			
Calories 230		Calories from Fat 72	
		% Daily Value*	
Total Fat 8g		12%	
Saturated Fat 1g		5%	
Trans Fat 0g			
Cholesterol 0mg		0%	
Sodium 160mg		7%	
Total Carbohydrate 37g		12%	
Dietary Fiber 4g		16%	
Sugars 1g			
Protein 3g			
Vitamin A		10%	
Vitamin C		8%	
Calcium		20%	
Iron		45%	
* Percent Daily Values are based on a 2,000 calorie diet. Your daily value may be higher or lower depending on your calorie needs.			
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Nutrition Facts	
8 servings per container	
Serving size	2/3 cup (55g)
Amount per serving	
Calories	230
% Daily Value*	
Total Fat 8g	10%
Saturated Fat 1g	5%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 160mg	7%
Total Carbohydrate 37g	13%
Dietary Fiber 4g	14%
Total Sugars 12g	
Includes 10g Added Sugars	20%
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 235mg	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.	

Carb Counting Lists

Each example $\approx$ 15 g Carb

1 cup milk

$\frac{1}{2}$ cup potatoes, corn, peas, legumes, oatmeal

$\frac{1}{3}$ cup rice, pasta, millet, quinoa, stuffing

1 slice bread

1 small tortilla, $\frac{1}{3}$ large tortilla

$\frac{1}{2}$ hamburger bun, $\frac{1}{2}$ pita bread, $\frac{1}{4}$ bagel

3 cups popcorn

1 cup cantaloupe, papaya, raspberries

1 “small” apple, orange, banana, 4 oz fruit juice

Measure Accurately



Use measuring cups and a food scale:
increase accuracy of carb counting



Non-Starchy Vegetables

- $\frac{1}{2}$ cup cooked $\approx$ 5 g carb

Asparagus, beets, broccoli, cabbage, carrots, cauliflower, eggplant, green beans, mushrooms, onions, pea pods, peppers, spinach, tomatoes, zucchini

Less carbs, but can be significant for T1DM dosing.

Vegetables: to count or not to count

- Example 1:
 - Liz has type 1 diabetes: her insulin:carb ratio 1:5
 - 1 unit rapid acting insulin for every 5 g carb
 - She eats 2 cups veggies
 - 1/2 cup cooked = 5 g carb
 - 2 cups cooked = 20 g carb
 - 1:5 ratio so needs 4 units of insulin
 - If she doesn't count the carbs in vegetables she is under-dosing by 4 units → hyperglycemic

Vegetables: to count or not to count

- Example 2:
 - Ed has type 1 diabetes, his insulin:carb ratio 1:20
 - 1 unit rapid acting insulin for every 20 g carb
 - He eats $\frac{1}{2}$ cup veggies
 - $\frac{1}{2}$ cup cooked = 5 g carb
 - 1:20 ratio so needs $\frac{1}{4}$ unit of insulin
 - Insignificant; with syringe cannot be measured
 - With a pump 0.25 units can be delivered but is likely not going to cause hyperglycemia if the $\frac{1}{2}$ cup vegetables is not dosed for.

Low Carb Snacks: when and why?

- If on shots and want a between meal snack without having to inject.
- If BG has been running above target.
- If on a pump and need to test basal rate adjustment: and want to remove the variable of the carb effect.
- *What can you do for your patients?*
 - Create a 1-2 page list of interesting snack ideas that use low carb foods.

Examples of Low Carb Snacks



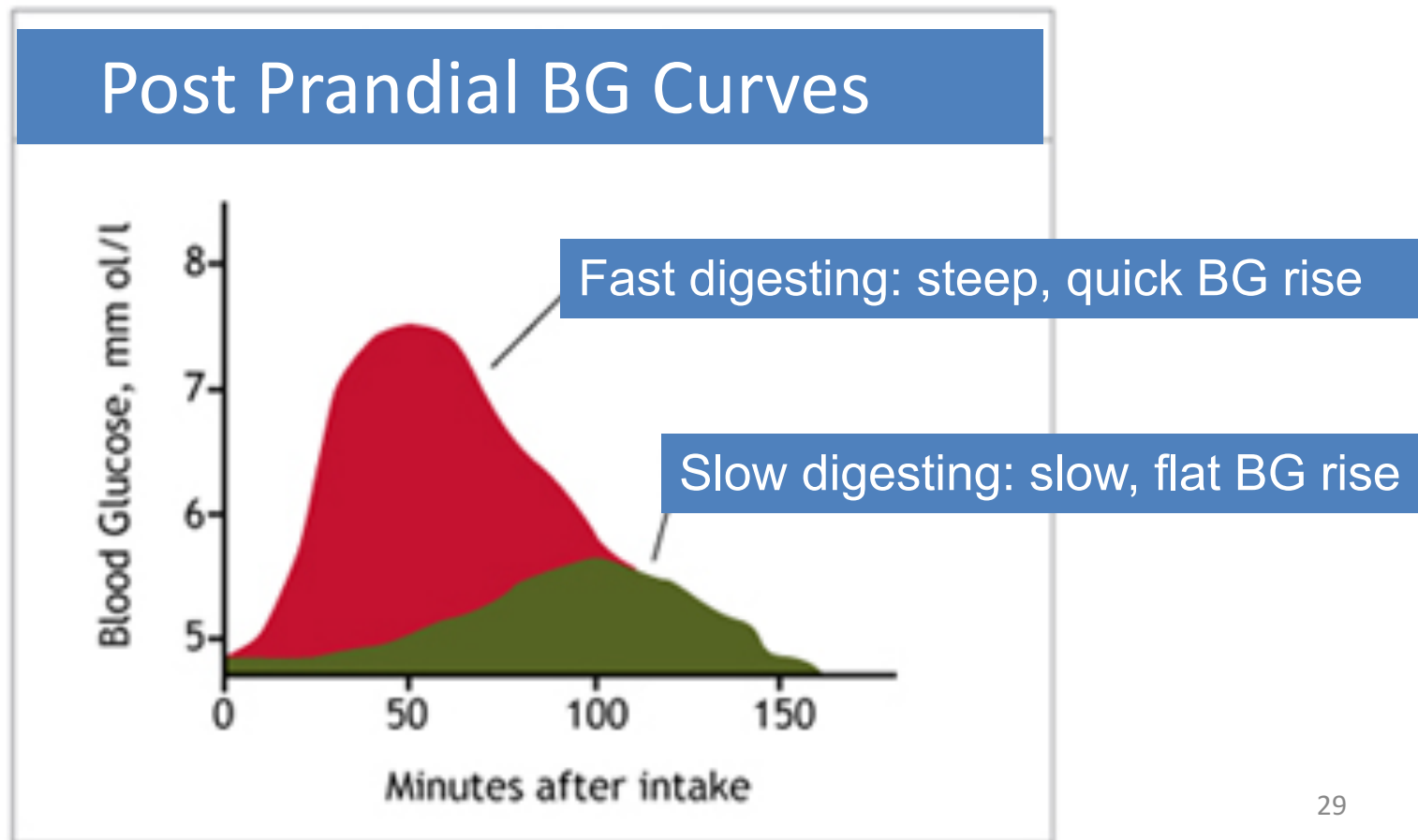
Skewing a Balanced Diet

- Some people respond to elevated BG by restricting healthy carb containing foods.
 - Example: if pre-meal high BG, parent might give water instead of milk, or withhold fruit for child with DM.
- To avoid a shot at snack, people may rely on high saturated fat snacks like salami or cheese.
- Some people might think giving more insulin must be “bad” so they restrict carbs in the diet.
- What are the long-term health implications?

Beyond Counting Carbs

Glycemic Effect of Food...

Post-prandial BG response is influenced by food choices.

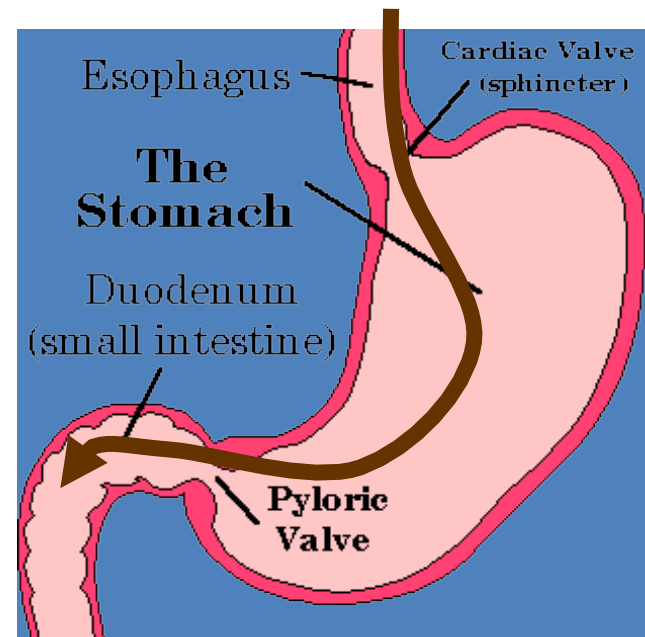


Variables affecting digestion times

Normally BG peak is about 1-2 hours post meal

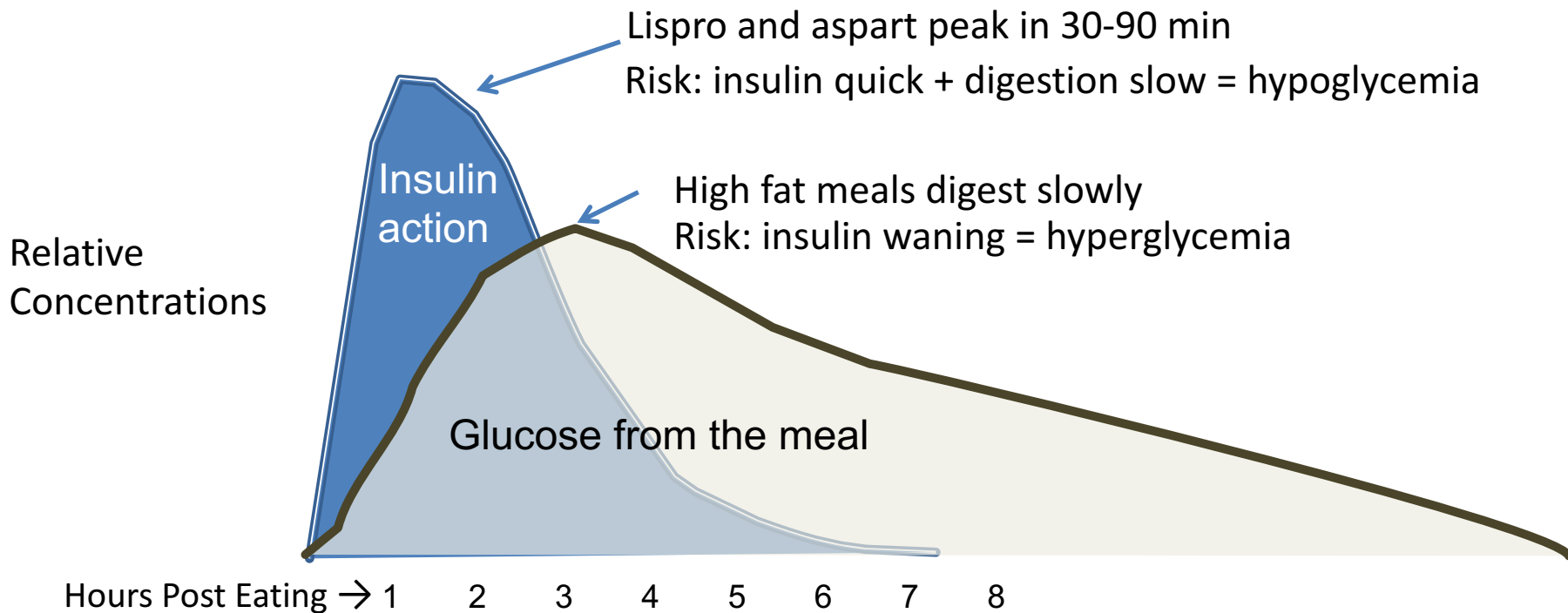
Exceptions:

- Liquid carbs: fastest
- Highly refined grains: fast
- High fiber foods: slow
- High fat, fried: slowest



Timing Matters: High Fat Meals

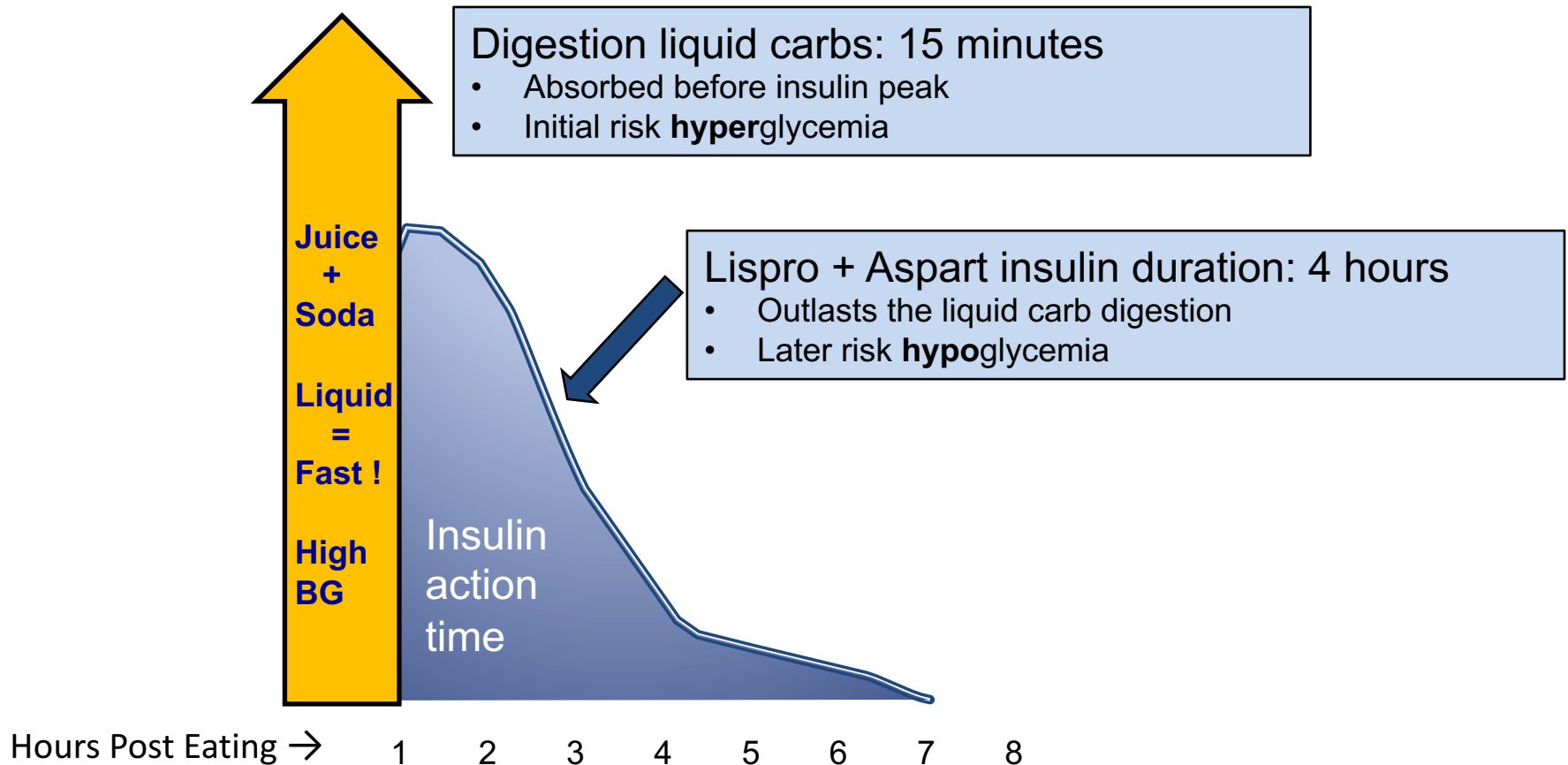
Graphs show mismatch in timing between rapid acting insulin and delayed BG rise after eating a high fat meal.



Solutions?

Pump users can use the combo bolus to deliver insulin slowly in pulses over time. Injection users can eat first and inject mid- to end of meal to give food a head start

Timing Matters: Liquid Carbs



Timing Matters with 70/30

70/30 = **70% NPH** **30% Regular**

Lunch: Must eat 4-5 hours after AM injection to match NPH.

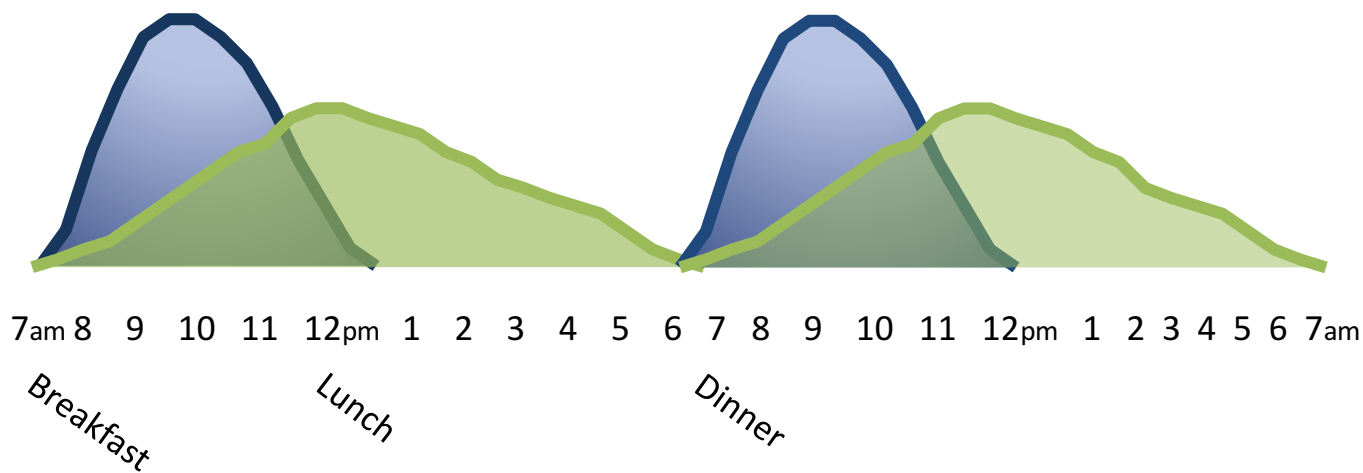
Meal times and amount of carbohydrates are FIXED!

NPH lasts all afternoon so may need unwanted snacks.

May get low in middle of night.

Insulin wanes early morning so can't sleep in.

Insulin action



Breakfast

Lunch

Dinner

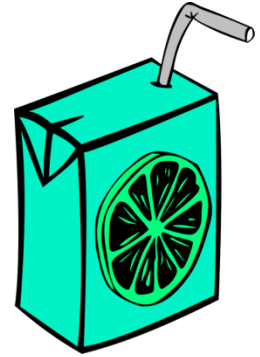
Inject 30 min before breakfast

Inject 30 min before dinner



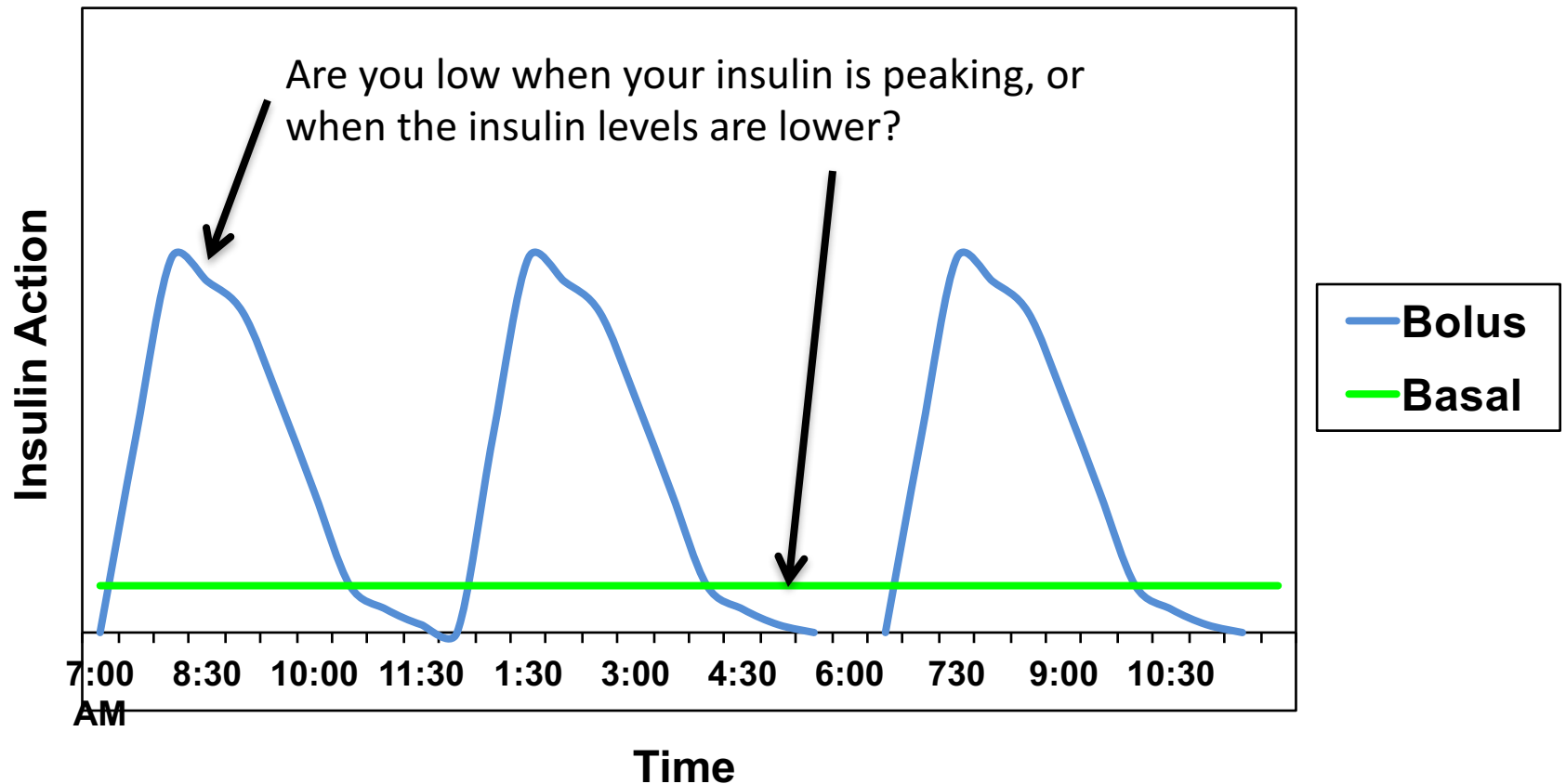
Treating Hypoglycemia

- BG below 70 mg/dl
 - take 15-20 grams of carbohydrate
(young kids likely need less, such as 5-10 grams)
 - 4 oz juice or regular soda
 - 1 Tbsp sugar, jam, honey
 - 4 glucose tabs
 - recheck BG in 15-20 minutes
 - Repeat as needed
 - BG below 50 mg/dl or low after exercise?
 - Likely need even more carbs to treat the initial low.



Consider Insulin on Board

When treating lows

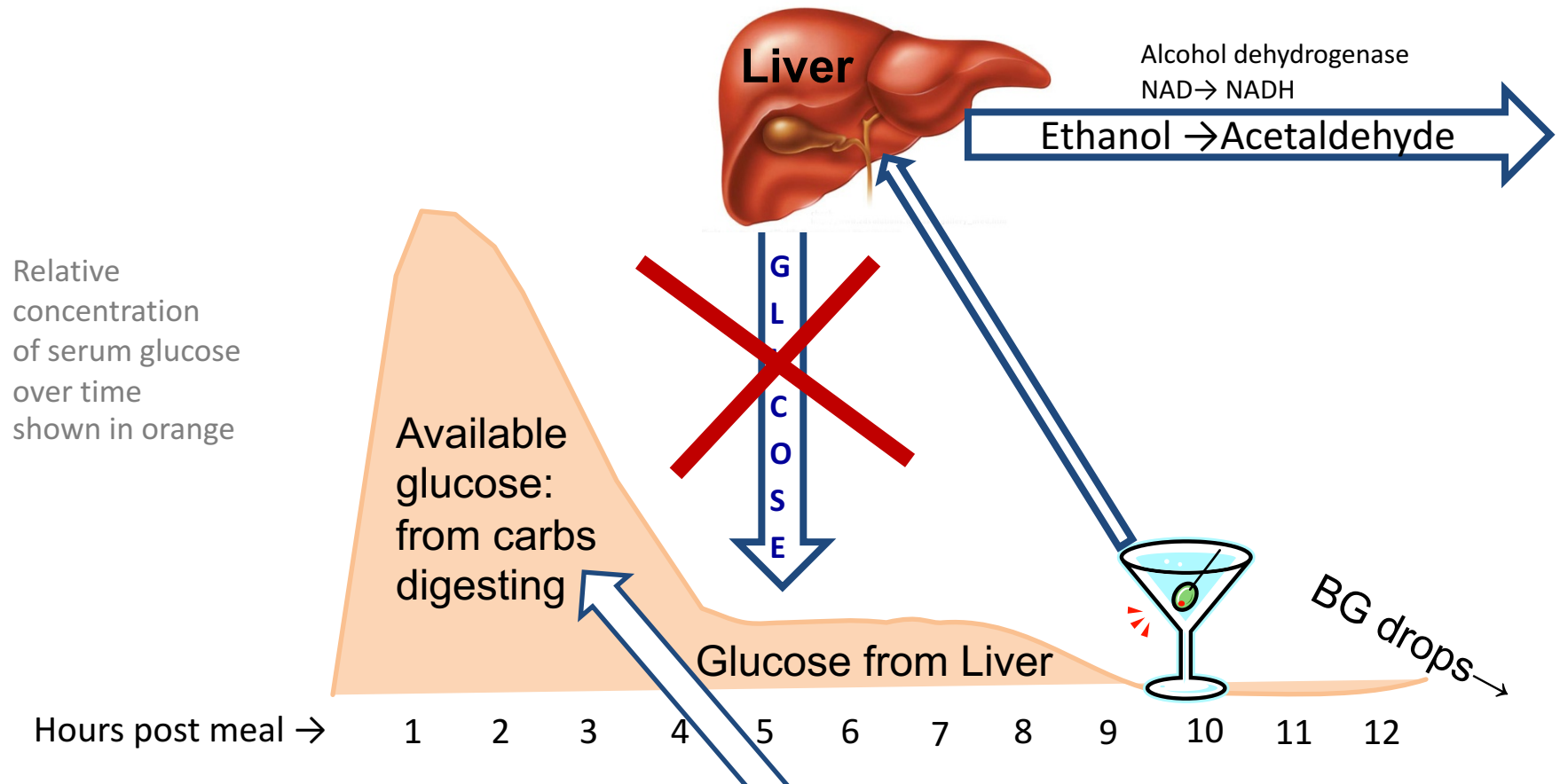


Consider the times hypoglycemia could occur as indicated by the two arrows above. Which would take more carbohydrate to resolve the hypoglycemia?

Hypoglycemia Unawareness

- Caused by frequent or severe low BG
 - Counter-regulatory hormone response becomes compromised
 - *Person loses symptoms of low BG*
-
- Avoid hypoglycemia for at least several weeks and hormone response improves and symptoms of low BG may return.

Alcohol Increases Risk of Hypoglycemia



Exogenously administered insulin keeps pushing BG down despite falling serum glucose levels, whereas a non-diabetic person's pancreas would reduce insulin production.

Carbs in Alcohol?



Hard liquor = 0 carbs



12 oz beer = 13 g carbs



Mixed drinks can have significant amounts of carb



Wine = 2 g carb

Recommended Limits on Alcohol

- If an adult with DM chooses to drink alcohol, they should be advised to drink in moderation:
 - Women: up to 1 drink per day
 - Men: up to 2 drinks per day
- What counts as a drink?
 - 12 oz beer
 - 5 oz wine
 - 1½ oz hard liquor



Don't drink on an empty stomach



Exercise Fuel Regulation

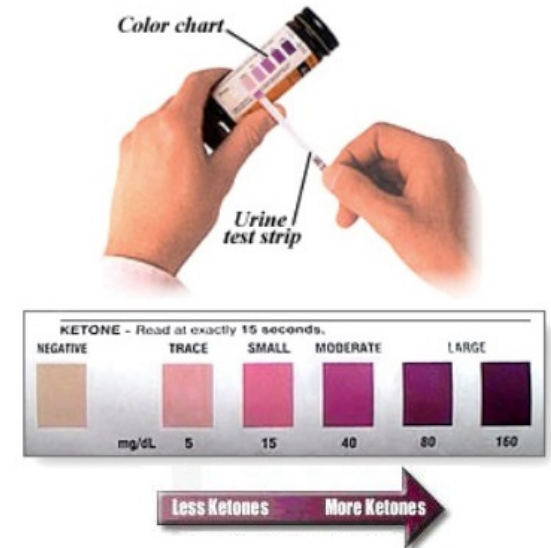
non-diabetic

- Normal metabolism during exercise:
 - ↑ counter regulatory hormones to mobilize fuels
glucagon, epinephrine, cortisol, growth hormone
 - ↑ hepatic glucose production
 - Gluconeogenesis
 - Glycogenolysis
 - ↑ release of free fatty acids from adipose
 - ↑ increase glucose uptake by muscle
 - ↓ insulin release from beta cells

Exercise Without Insulin

such as T1DM who omitted insulin

- Still have increase in:
 - Counter regulatory hormones
 - Hepatic glucose output
 - Free fatty acid release
- But without insulin:
 - muscles take up glucose less effectively
 - fats are not properly metabolized
 - ketone synthesis increases
- Net result:
 - hyperglycemia and ketosis



Exercise Precautions

- If BG levels are over 300 mg/dL with T1DM
 - check for ketones with urine dip-stick or blood ketone meter
- Avoid exercise anytime ketones are increased.
- Use caution if blood glucose is over 300 mg/dL
 - even without ketones
 - glucose and fatty acids will still be mobilized
 - BG levels may rise further because of counter regulatory hormones

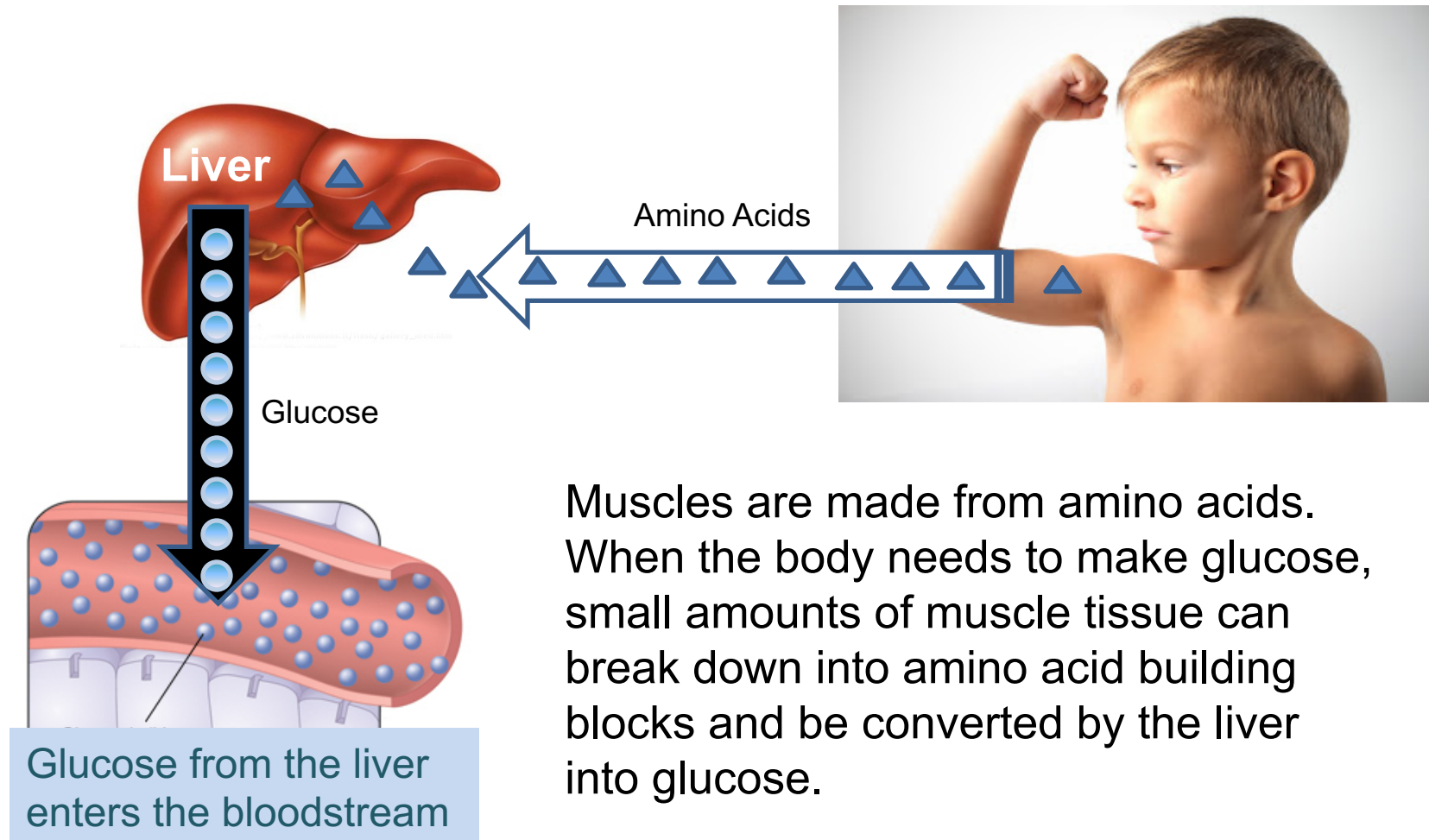
A person with T2DM has endogenous insulin, so is not at much risk for ketoacidosis.

Exercise may increase insulin sensitivity for the person with T2DM and actually help lower BG even when hyperglycemic.

When Glycogen Stores are Low

- Exercise uses up glycogen stores if not enough carbohydrate is eaten for exercise.
- Depleted glycogen increases risk of low BG.
 - When glycogen stores are low, glucose is pulled out of the blood to refill stores; BG can drop unexpectedly.
- You need to eat enough carbohydrate to keep the glycogen stores amply filled.
 - Skipping meals and low carb diets make it difficult to have adequate glycogen stores.

Making Glucose



T1DM: Beware delayed hypoglycemia



- Muscle contraction stimulates glucose uptake from blood by increasing GLUT4 at cell surface
- Insulin sensitivity may persist for hours
- Post exercise period: glucose shifts from blood back to muscle as glycogen is replenished

Late Onset Hypoglycemia

- Liver and muscle replete glycogen stores by transporting glucose in from the bloodstream.
- Hypoglycemia can occur up to 24 hrs after exercise
 - indicates that insufficient carbohydrate was available in relation to insulin and exercise.
 - Next time eat more snacks or consider reducing the dose of insulin.

Exercise: carb tips

- For unplanned exercise add a carbohydrate snack to prevent low blood sugar.
- Eat carbohydrates before, during, and after exercise, as needed to prevent hypoglycemia.
- Always keep carbohydrate foods readily available during exercise and to treat lows.
- If pre-exercise blood glucose is < 100 mg/dl have a carb snack first.

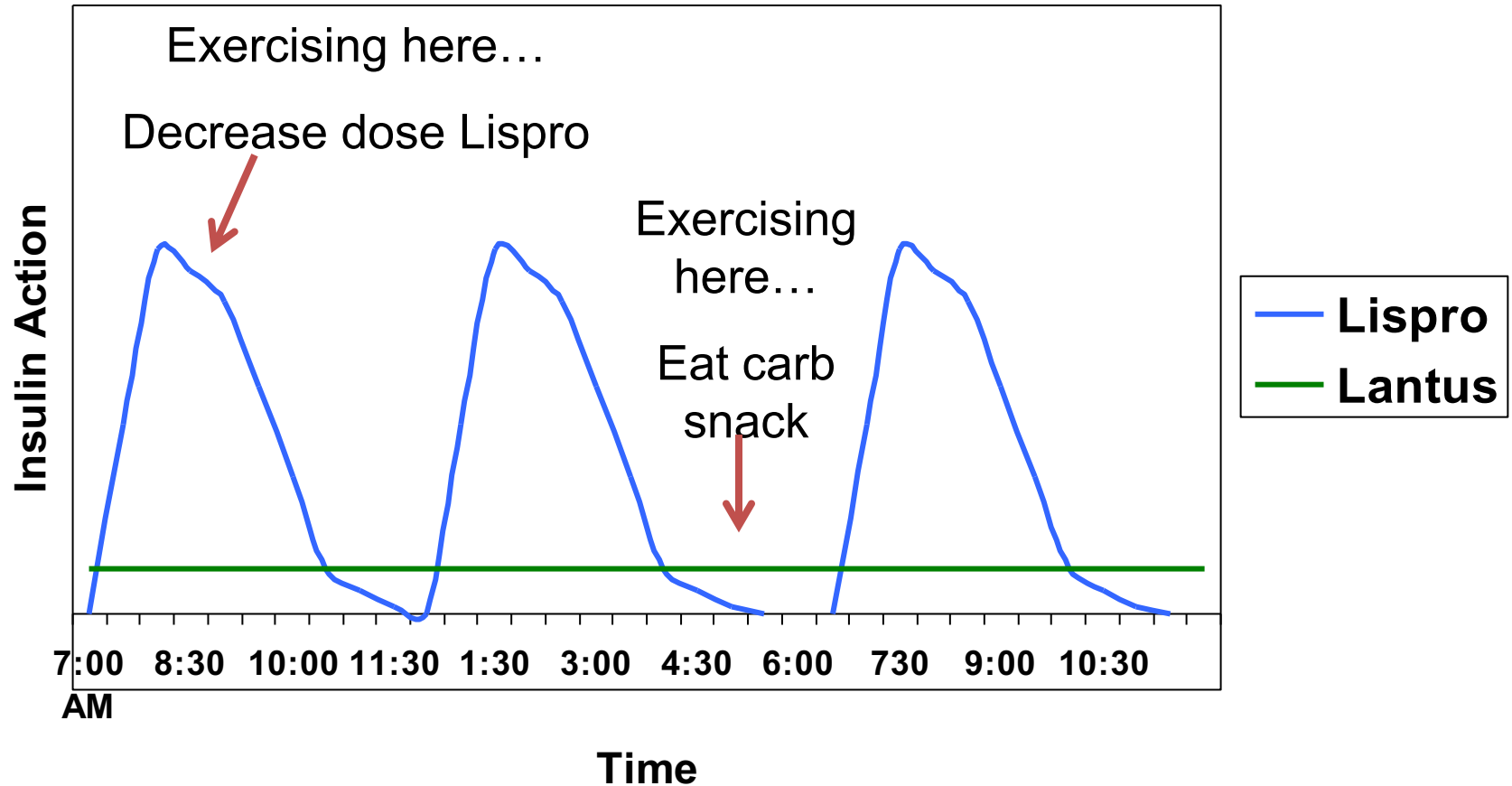
Exercise Guidelines

Insulin Adjustments

- If exercise is planned for just before or after a meal, consider decreasing the short acting insulin that covers that meal.
- If exercise is planned for 3-4 hours after a meal, consider adding a carbohydrate snack.
- Pump users: may try temporary basal reduction.
- People may have a different insulin to carb ratio on active versus sedentary days.
 - In some cases doses are reduced by 20-50%

Exercise...

Adjustments to prevent hypoglycemia



Why might exercise raise BG levels?



- Catecholamines and glucagon raise BG
 - Hepatic glucose release
 - Be cautious about “over-correcting” with too much insulin

Exercise Health Evaluation

- Existing Complications:
 - Retinopathy: no heavy weight lifting, or jarring
 - Peripheral Neuropathy: limit weight bearing and repetitive foot motions. Avoid jumping, pounding, jogging, stair master, treadmill.
 - Autonomic Neuropathy: can lead to cardiac events and sudden death.
 - Cardiac Risks: Perform exercise stress test
 - PVD: try upper body, arm-chair, pool exercise

Questions?