Helping Patients with Diabetes

Session 3: Insulin Therapy

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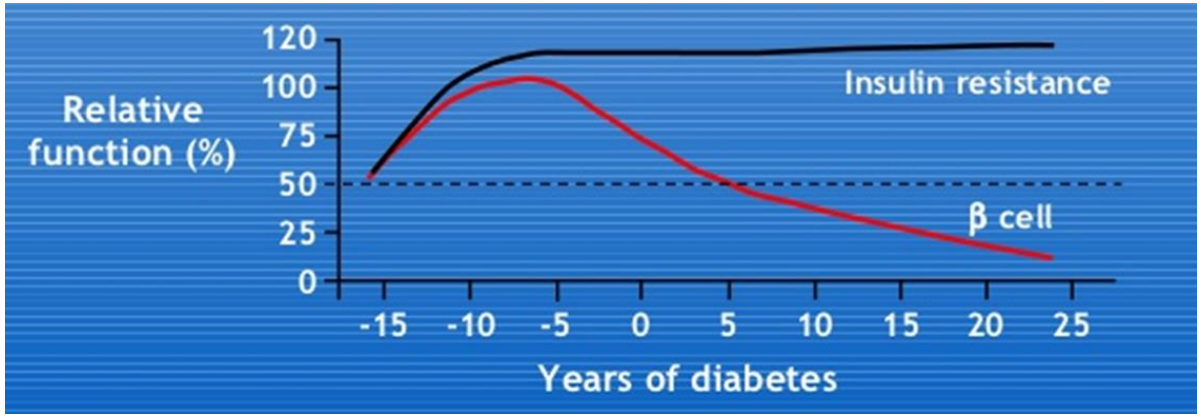
June 2023

Many adults with type 2 diabetes eventually require and benefit from insulin therapy

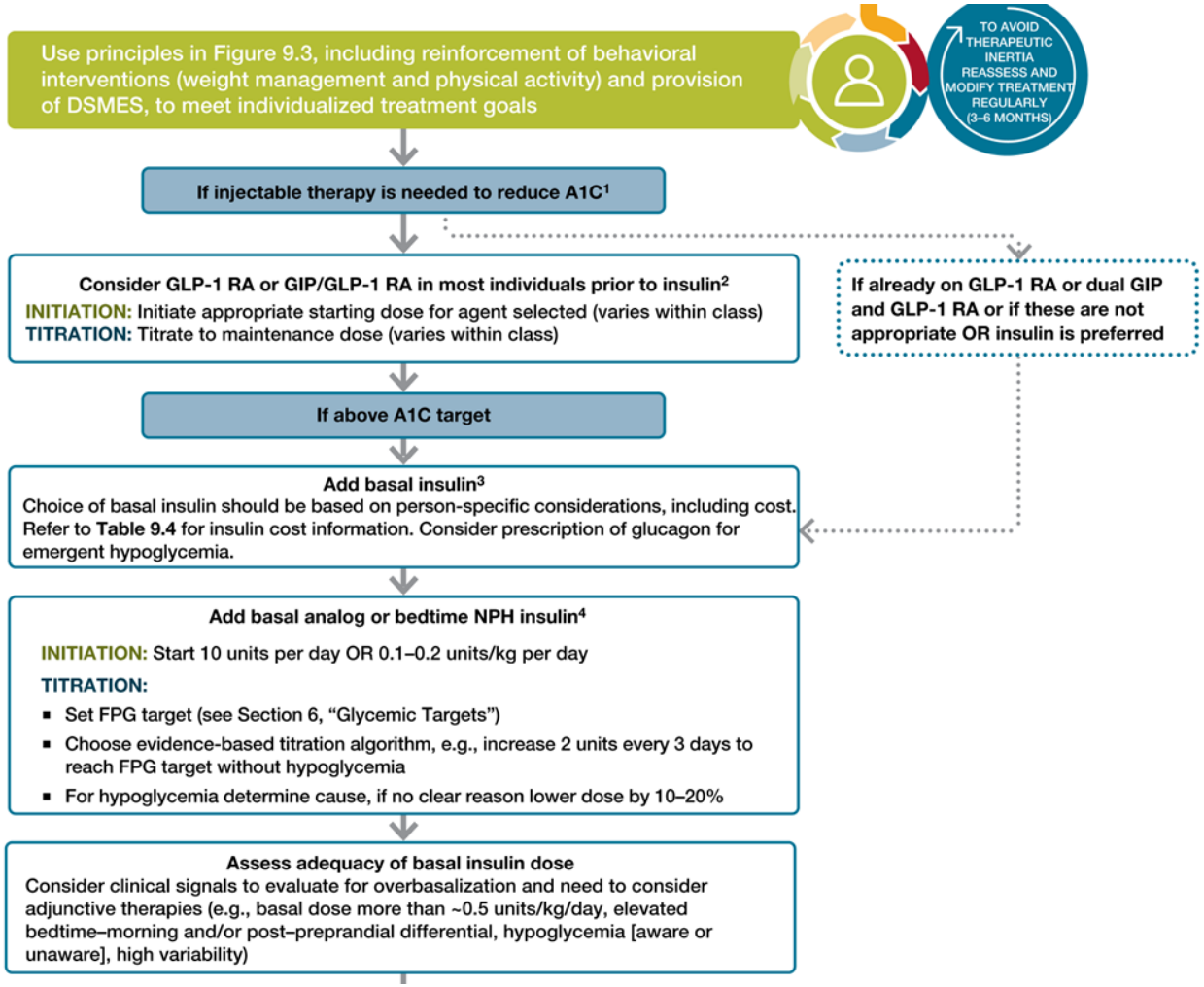
- The ***progressive nature of type 2 diabetes*** should be regularly and objectively explained to patients.
- Clinicians should ***avoid using insulin as a threat or describing it as a sign of personal failure or punishment.***
  - Rather, the utility and importance of insulin to maintain glycemic control once progression of the disease overcomes the effect of other agents should be emphasized.



Explain that diabetes gets worse over time
It is not the patient's fault
It does not mean they "failed"

ADA 2023 Standards of Care

- 9.10 In adults with type 2 diabetes, a ***glucagon-like peptide 1 receptor agonist (GLP1 RA)*** is *preferred to insulin* when possible. A
- 9.11 *If insulin is used,* ***combination therapy with a GLP1 RA*** *is recommended* for greater efficacy, durability of treatment effect, and weight and hypoglycemia benefit. A
  - Guidance on how to add in a GLP1 RA medication to Basal-Bolus Insulin:
    - Reduce Bolus insulin dose by ½ with initial dose of the GLP1 RA
    - Stop Bolus insulin as increase GLP1 RA dose –
    - Titrate GLP1 RA to max tolerated dose, adjust Basal insulin as needed
    - Add back bolus insulin to meals with high pp BG



Insulin Therapy - Educating Patients

- Educating and involving patients in insulin management is beneficial – including **education** regarding
  - correct injection technique
  - blood glucose monitoring
  - self-titration of insulin doses
  - nutrition
  - avoidance and appropriate treatment of hypoglycemia

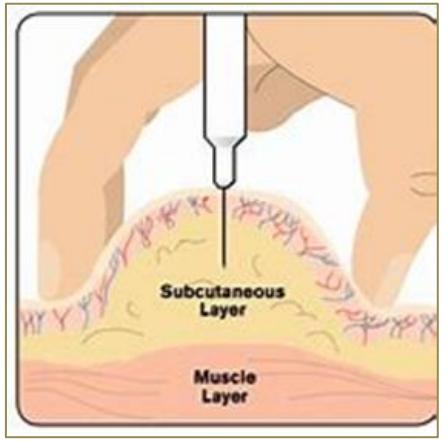
Insulin Injection Technique

- Ensuring that individuals and/or caregivers understand correct insulin injection technique is important to optimize glucose control and insulin use safety.
  - It is important that insulin be delivered into the proper tissue in the correct way ("show me" – how & where - very valuable in ensuring proper technique)

- Proper insulin injection technique includes
  - injecting into appropriate body areas
  - injection *site rotation*
  - appropriate care of injection sites to avoid infection or other complications
    - Ongoing debate regarding use of alcohol swab – most say if site is clean, no need to use alcohol / can use alcohol or water or soap & water to clean if necessary
    - Clean hands with soap and water
  - avoidance of intramuscular (IM) insulin delivery

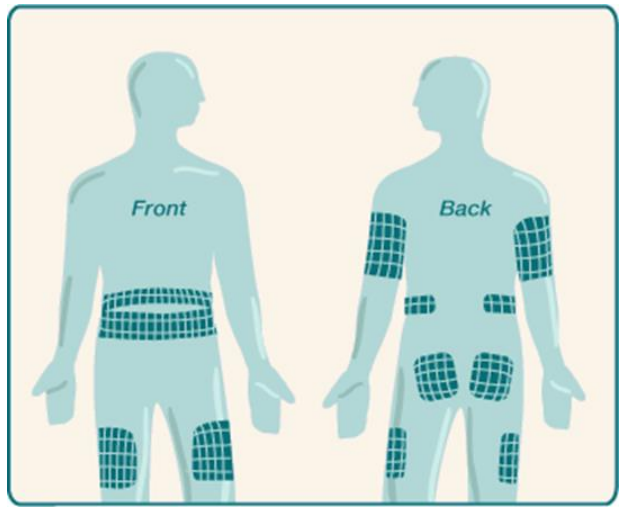
Insulin Injection Technique

- Exogenously delivered insulin should be injected into **subcutaneous tissue**, not intramuscularly.
  - Inadvertent IM injection can lead to unpredictable insulin absorption and variable effects on glucose and is associated with frequent and unexplained hypoglycemia (influenced by activity of the muscle)
  - Risk for IM insulin delivery is increased
    - in younger, **leaner individuals** when injecting into the limbs rather than truncal sites (abdomen and buttocks)
    - when using **longer needles** (recent evidence supports the use of short needles [e.g., 4-mm pen needles] as effective and well tolerated when compared with longer needles, including a study performed in adults with obesity).
  - loosely pinch up skin & subcutaneous tissue
  - insert the needle
  - relax fingers as inject
    - If you have sample insulin needles, practice needle insertion on yourself

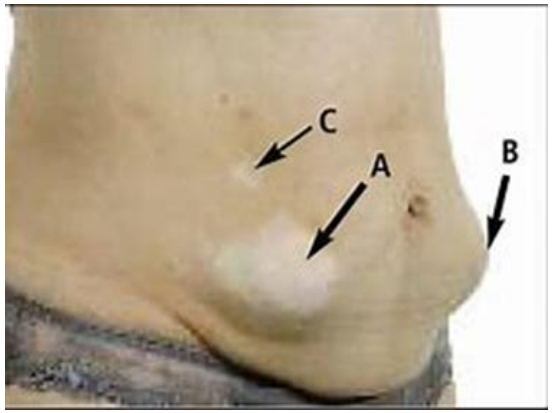


Insulin Injection Technique

- Recommended sites for insulin injection include the
  - abdomen
  - thigh
  - buttock
  - upper arm



- Injection site rotation is necessary to avoid lipohypertrophy
  - an accumulation of subcutaneous fat in response to the adipogenic actions of insulin at a site of multiple injections.
  - appears as soft, smooth raised areas
  - can contribute to erratic insulin absorption, increased glycemic variability, and unexplained hypoglycemic episodes.



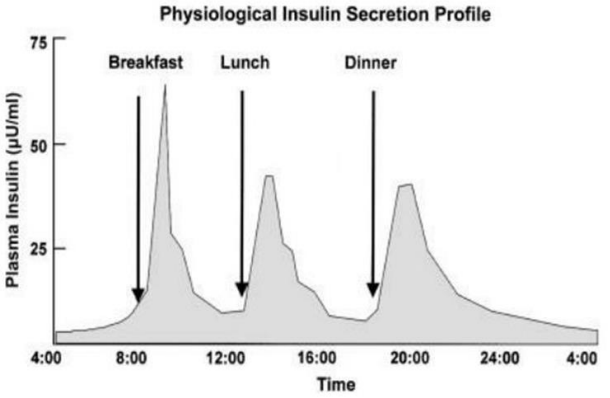
Insulins

- Dosing to try to replace /mimic the natural secretion of insulin
  - **Basal insulin** is designed to *suppress hepatic glucose production and improve basal (fasting) hyperglycemia*
  - **Bolus (mealtime, prandial) Insulin** –as rapid-acting insulin - limits hyperglycemia after *meals(covers food carbs)* – should hold(not give) if NPO or not eating
  - **Correction Insulin** – extra rapid-acting insulin given for *high blood glucose* to *decrease BG levels to target range* – based on patient's "sensitivity or correction factor" - can be used to:
    - Add more insulin to a mealtime bolus to correct for a high premeal blood glucose
    - Used alone *to correct a high blood glucose* outside of mealtime or if NPO or illness

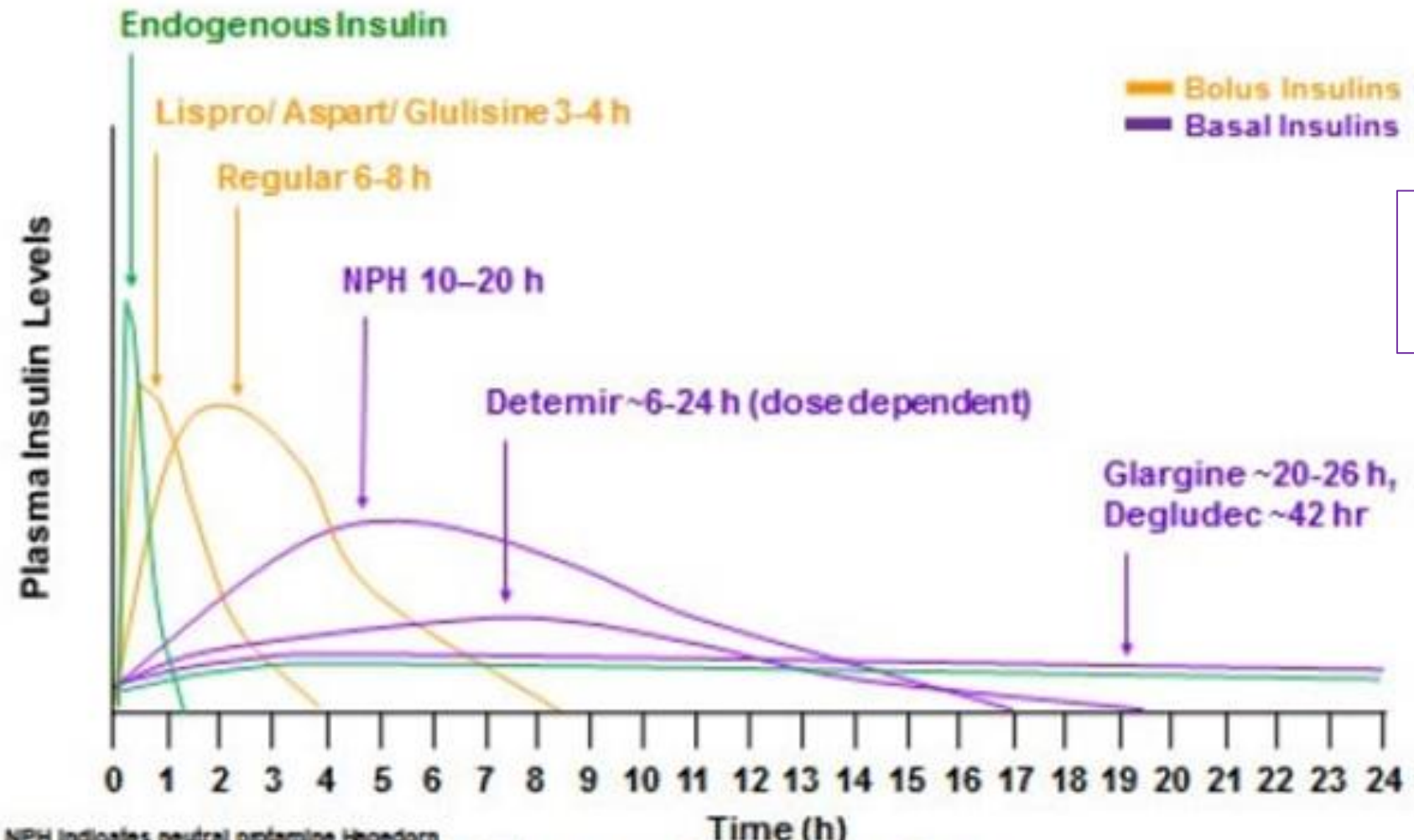
Definitions

1) **Basal Insulin:**
   - Prevents between meal and overnight hyperglycemia

2) **Bolus insulin:**
   - Limits hyperglycemia after meals



Action Profiles of Basal and Bolus Insulins



New once-weekly
Basal insulins
in research phase

NPH indicates neutral protamine Hagedorn
Note: action curves are approximations for illustrative purposes; actual patient response will vary
Mayfield JA, et al. *Am Fam Physician*. 2004;70:489-500; Plank J, et al. *Diabetes Care*. 2006;28:1107-1112, Diabetologia 2011;54 (Suppl):S429, Diabetes 2011;60(Suppl1A);LB14.

Basal Insulin – adding to other T2D meds

- Basal insulin alone is the **most convenient initial insulin** treatment and can be added to metformin and other noninsulin medications.
- Can use human NPH insulin or a long-acting insulin analog to control fasting glucose
  - The principal action of basal insulin is to *restrain hepatic glucose production* and limit hyperglycemia overnight and between meals.
- Starting doses can be estimated based on
  - body weight (0.1–0.2 units/kg/day) & the degree of hyperglycemia
    - another option is to start with 10 units
- Doses can be optimized with *individualized titration* over days to weeks as needed
  - Can teach patient/ care team members to adjust (titrate) dose to get BGs into the FBS target range
    - E.g., increase by 1 unit every day or increase dose by 2 units every 3 days until BGs are in the target range (longer duration for longer acting)
    - For Hypoglycemia (unexplained) reduce dose by 10-20%

Basal Insulin – adding to other T2D meds – example

Case example

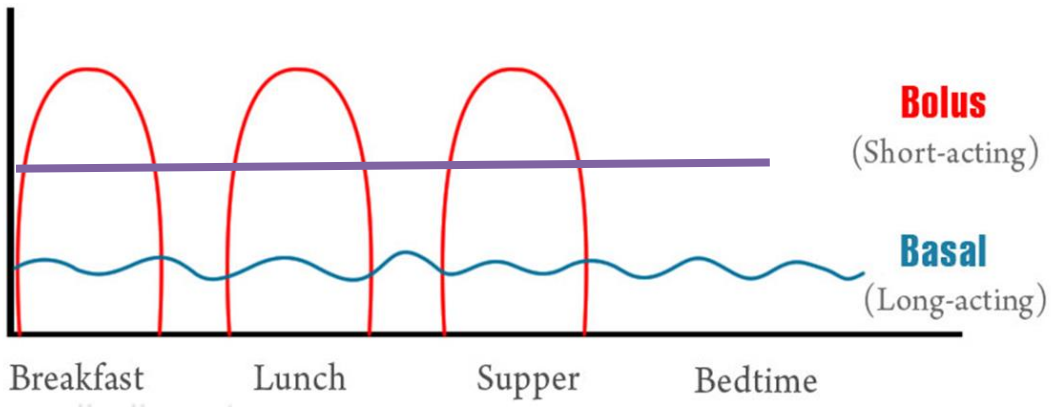
55-year-old man with A1c 8.2% despite maximum dose metformin, Semaglutide (Ozempic) & Empagliflozin (Jardiance)

- weight 240# /110 KG with FBS 140-210
- Target range for FBS 80-130
- Estimate 11 to 22 U glargine at HS (0.1-02u/kg)
  - opt to have him start with 16u
- The patient self-titrates dose up to 30u using algorithm
- Wakes up with BG of 66- Contacts care team
- Care team has him Reduce dose back to 27u (by 10%) & asks patient to call in BG results in 3 days (may need 28 u, etc. ….)

Research has shown that having patients follow algorithm to titrate the insulin dose reduces delay in getting BGs to target.

Basal Insulin – adding to other diabetes meds

- Clinicians should be aware of the potential for overbasalization with insulin therapy. Clinical signals that may prompt evaluation of overbasalization include:
  - basal dose greater than ~0.5 units/kg
  - high bedtime–morning or post-preprandial glucose differential (e.g., bedtime–morning glucose differential ≥50 mg/dL)
  - hypoglycemia (aware or unaware)
  - “feeding the insulin”
  - high variability



From: **9. Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes—2023**

Diabetes Care. 2022;46(Supplement_1):S140-S157. doi:10.2337/dc23-S009

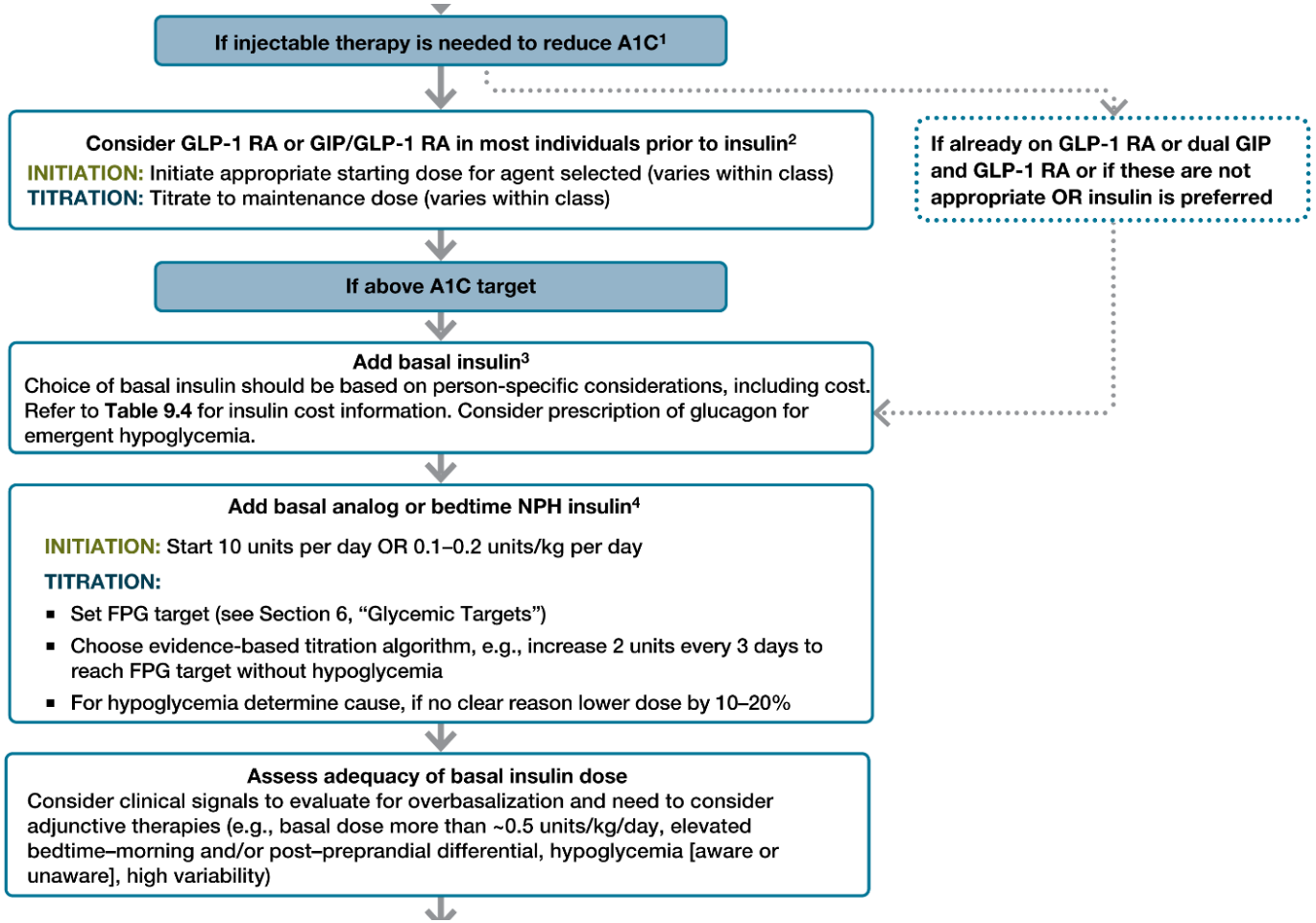


Figure Legend: Intensifying to injectable therapies in type 2 diabetes. DSMES, diabetes self-management education and support; FPG, fasting plasma glucose; GLP-1 RA, glucagon-like peptide 1 receptor agonist; max, maximum; PPG, postprandial glucose. Adapted from Davies et al. (43).

Prandial (mealtime) Insulin

- Many individuals with type 2 diabetes require doses of **insulin before meals**, in addition to basal insulin, to reach glycemic targets.
  - If the individual is not already being treated with a GLP-1 RA, a **GLP-1 RA should be considered prior to prandial insulin** to further address prandial control and to minimize the risks of hypoglycemia and weight gain associated with insulin therapy.
- For individuals who advance to prandial insulin, a prandial insulin dose of ***4 units or 10% of the amount of basal*** insulin at **one meal** (the *largest meal* or the meal with the *greatest postprandial excursion*) is a safe estimate for initiating therapy.
  - The term **'basal-plus therapy'** describes a regimen of one basal insulin injection and the *stepwise* addition of *one to three preprandial short-acting* insulin injections per day
  - **Full basal-bolus therapy =** *basal insulin plus three short-acting insulin injections* per day.
- The prandial insulin regimen can then be intensified based on individual needs.
  - With ***significant additions to the prandial insulin dose***, particularly with the evening meal, consideration should be given to **decreasing basal insulin** (begin by decreasing by 4u or 10% of basal dose)

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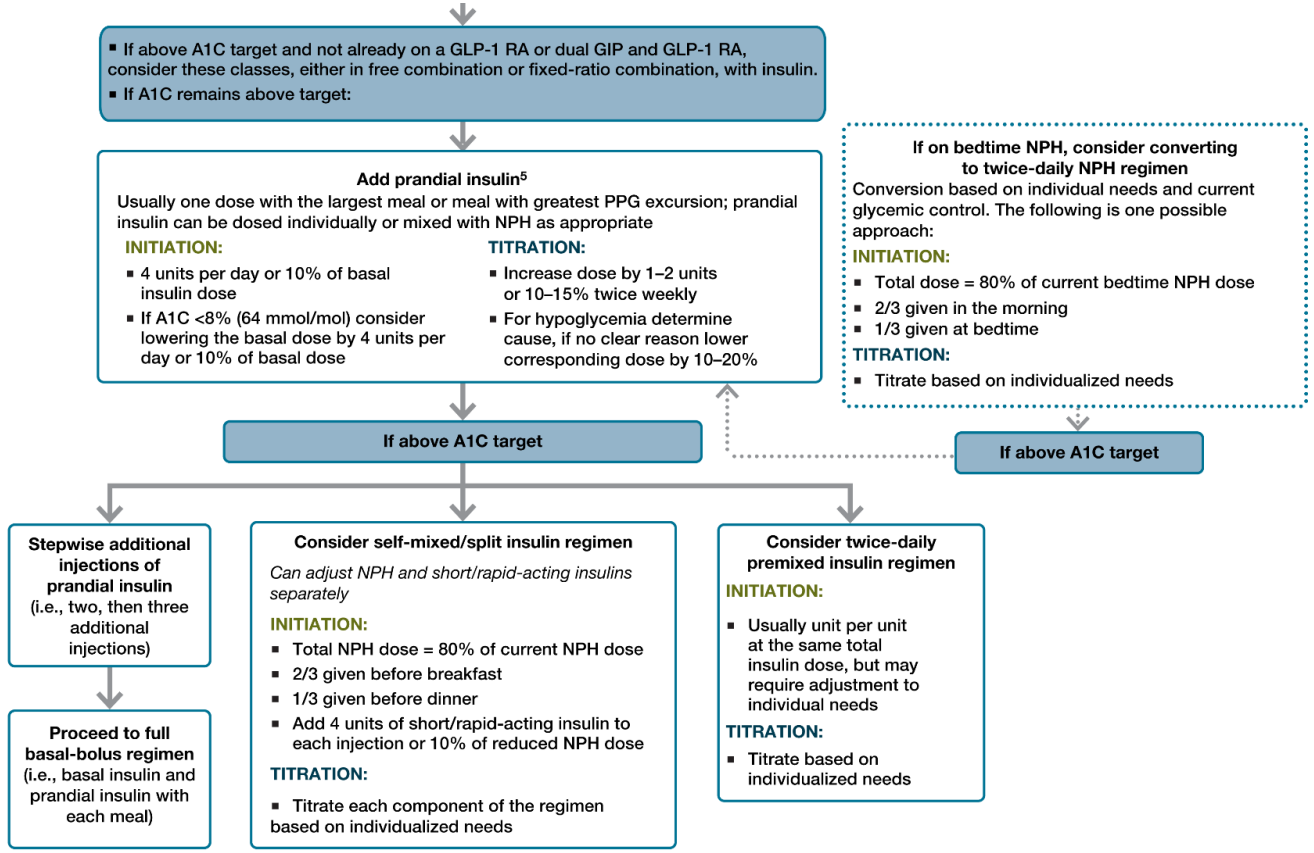


1. Consider insulin as the first injectable if evidence of ongoing catabolism, symptoms of hyperglycemia are present, when A1C levels (>10% [86 mmol/mol]) or blood glucose levels (300 mg/dL [16.7 mmol/L]) are very high, or a diagnosis of type 1 diabetes is a possibility.
2. When selecting GLP-1 RA, consider individual preference, A1C lowering, weight-lowering effect, or fequency of injection. If CVD is present, consider GLP-1 RA with proven CVD benefit. Oral or injectable GLP-1 RA are appropriate.
3. For people on GLP-1 RA and basal insulin combination, consider use of a fixed-ratio combination product (IDegLira or iGlarLixi).
4. Consider switching from evening NPH to a basal analog if the individual develops hypoglycemia and/or frequently forgets to administer NPH in the evening and would be better managed with an A.M. dose of a long-acting basal insulin.
5. If adding prandial insulin to NPH, consider initiation of a self-mixed or premixed insulin regimen to decrease the number of injections required.

Figure Legend: Intensifying to injectable therapies in type 2 diabetes. DSMES, diabetes self-management education and support; FPG, fasting plasma glucose; GLP-1 RA, glucagon-like peptide 1 receptor agonist; max, maximum; PPG, postprandial glucose. Adapted from Davies et al. (43).

Adding prandial (rapid-acting) insulin – the Insulin-to-Carb Ratio (ICR)

- **Bolus (mealtime, prandial) Insulin** –as rapid-acting insulin - limits hyperglycemia after meals(covers food carbs) – should *hold if NPO or not eating*
- The **insulin-to-carb ratio (ICR)** is a way to get closer to the right amount of insulin for the carbohydrates in a meal (or snack) for any individual patient
  - More critical in patients with less endogenous insulin
  - It means the patient will take ***1 unit of insulin for a certain amount of carbohydrate***
    - This is usually expressed as "1 unit of insulin covers XX grams of carbs" or 1:XX
  - The ICR depends on how sensitive or resistant the patient is to insulin –
    - The more sensitive they are to insulin the more grams of carb 1 unit of insulin will cover (goal is to limit postprandial BG rise to no more than 50 points or BG of 180 (200))
      - Insulin sensitivity can vary according to the time of day, from person to person, and is affected by physical activity and stress.
    - The ICR can be calculated using the 500 rule (500/TDI) or can be based on weight

Calculating Insulin Dose :: Diabetes Education Online (ucsf.edu)

Estimating an Insulin to Carb Ratio

Based on Total Daily Dose

- 8—11 units 1:50
- 12—14 units 1:40
- 15—18 units 1:30
- 19—21 units 1:25
- 22—27 units 1:20
- 28—35 units 1:15
- 36—45 units 1:12
- 46—55 units 1:10
- 56—65 units 1:8
- 66—80 units 1:6
- 81—120 units 1:5
- >120 units 1:4

Based on the 500 Rule

Based on Body Weight

- <60 lb. 1:30
- 60—80 lb. 1:25
- 81—100 lb. 1:20
- 101—120 lb. 1:18
- 121—140 lb. 1:15
- 141—170 lb. 1:12
- 171—200 lb. 1:10
- 201—230 lb. 1:8
- 231—270 lb. 1:6
- >270 lb. 1:5

Fails to consider body composition & insulin resistance or other meds

With patient taking GLP1 RA would go with a lower (weaker) ICR and titrate as needed – e.g., 1:10 instead of 1:6

Covering Meal Carbs

- Even if eating **fixed amounts of carb** at a meal – you need to base the prescribed **fixed meal insulin dose** on an ICR that is appropriate to the patient
  - No need for the patient to do carb counting but having an idea of the correct ICR to base meal dose on for any given patient can help improve the response to insulin therapy

- E.g. - If the estimated insulin-to-carb ratio (ICR) is 1 unit of insulin for every 10 grams of carbohydrate (written 1:10) - will take 1 unit of insulin for every 10 grams of carbohydrate eaten – if eat 30 grams will take 3units; if eat 60 grams will take 6 units
  - If ICR is 1:15 – will take 1 unit for every 15 grams of carb eaten
    - If eat 30 grams will take 2units; if eat 60 grams of Carb will take 4 units
- For fixed meal doses – e.g., patient eats ~45 grams of carb each meal and weighs ~120# with estimated ICR of 1:15 - will take 3 units with each meal
  - Or if patient eats 30g Carb with Breakfast, 45 grams with Lunch & 60 grams with Dinner – would take 2u with B, 3u with L and 4 units with D
- For varying meal amounts - you can get an estimate of what a “small”, “medium” or “large” meal is for that patient (e.g., 30 grams CHO, 60 grams CHO, 90 grams CHO)
  - Utilize the patient’s ICR to estimate dose for each (e.g., 1:10)
  - Give 3 units for a small meal, 6 for a medium meal and 9 for a large meal
  - Can add *correction insulin* if pre-meal BG is above target

Adding prandial (rapid-acting) insulin – usually need both meal coverage & correction insulin

Bolus (mealtime, prandial) Insulin –as rapid-acting insulin - limits hyperglycemia after meals(covers food carbs) – should ***hold if NPO or not eating***

Correction Insulin – ***extra rapid-acting insulin given for high blood glucose*** to decrease BG levels to ***target range*** – based on patient's "sensitivity or correction factor" -

- The dose of "correction insulin" is the amount of insulin needed to lower the BG from its current level to the target level over the time of insulin action – depends on how sensitive the patient is to insulin
- You want to correct a high BG to a target level BG (not to zero)
- Correction insulin doses can be used to:
  - **add more insulin to a mealtime bolus to correct for a high premeal blood glucose** - e.g., if the patient had a Correction Factor of 30 (1 unit lowers the BG 30 points) you might provide this guidance:
    - 5u if BG 80-140 (only needs meal coverage since premeal BG is in target range for this patient)
    - 6u (5u+1u) if 141-170 (adding 1 unit for BG 30 points above target range to the meal insulin coverage dose)
    - 7u(5+2u) if 171-200, etc. (adding 2 units for 60 points above target range) or use Correction Formula to be more precise
  - **used alone to correct a high blood glucose outside of mealtime or if NPO or with illness**
    - Can be added to oral therapy and/or basal insulin

Calculating the Correction Dose

Correction dose of Insulin = $\dfrac{\text{Current BG- Target BG}}{\text{CF}}$

Correction Factor (CF) or Sensitivity Factor (SF)

The CF = the mg/dl drop in BG caused by 1 unit of insulin
(depends on sensitivity to insulin - weight, age renal function)

The right correction dose will return the BG to within
30 mg/dl of the target blood glucose about **3-4 hours**
after the dose is injected

Calculating a Correction Factor(CF)/Sensitivity Factor(SF)

For patient new to insulin/sick day insulin calculate by using
3000/weight in Kg

or - If patient already treated with insulin can Use 1700/TDD*

e.g., patient weighs 100 kg
3000/100kg=30
1u should reduce BG by 30 points

If impaired renal function/older age – will need "weaker" correction dose by using larger CF (SF) number (e.g., 50 – 1u lowers BG 50 points vs 30 points)
This gives **less insulin** as the correction dose of insulin

With severe IR/infection, may need to go to "stronger" correction dose by using smaller CF (SF) number (e.g., 20 - 1u lowers BG 20 points vs 30 points)
This gives **more insulin** as the correction dose of insulin

Quick “cheat sheet” for Correction Factor(CF)/Sensitivity Factor(SF)

CF based on patient weight

- <60 lb. = 100
- 60—80 lb. = 75
- 81—100 lb. = 60
- 101—120 lb. = 50
- 121—140 lb. = 45
- 141—170 lb. = 40
- 171—200 lb. = 30
- 201—230 lb. = 25
- 231—270 lb. = 20
- >270 lb. = 15

Based on 3x ICR weight formula

Adding Correction Insulin to Prandial (rapid-acting) Insulin for Meal Coverage

- **Add insulin to a mealtime bolus to correct for a high premeal blood glucose** –
- Case example: the patient is on a fixed carb diet (50 grams per meal and 5u Rapid Acting insulin for meal coverage dose [based on ICR of 1:10])
- They have a **Correction Factor of ~30** (1 unit lowers the BG 30 points)
  - If their premeal target is 80-140 range (target BG 110) – and if their premeal BG is above target (e.g.,200) they can add correction insulin to their premeal dose to help reduce the high BG as well as cover the carbs.
  - The patient can use the ***Correction Formula*** to calculate the dose of correction insulin: **[Current BG – Target BG/CF = Correction dose]**
    - For this patient that would be 200 – 110 = 90 → 90/30 = 3u – they would add this to the 5u meal dose for 8u total dose before the meal
  - However, many patients are not comfortable with math, especially division – you might provide a ***Correction Scale*** for them to use (less precise but still helpful):
    - 5u if BG 80-140 (only needs meal coverage since premeal BG is in target range for this patient)
    - 6u (5u+1u) if 141-170 (adding 1 unit for BG 30 points above target range to the meal insulin coverage dose)
    - 7u(5+2u) if 171-200, etc. (adding 2 units for 60 points above target range) - see cheat sheet

Be sure to practice with them and have them demonstrate ("show me") back how to use

Correction Scales for different Correction Factors – general

- **CF 50:** for BG 140-191 give 1u; 191-240 2u; 241-290 3u; 291-340 4u; 341-390 5u; 391-440 6u; 441-490 7u, etc.

- **CF 40:** for BG 140-180 give 1u; 181-220 2u; 221-260 3u, 261-300 4u, 301-340 5u, 341-380 6u, 381-420 7u, 421-460 8u, 461-500 9u, etc.

- **CF 30:** for BG 140-1700 give 1u; 171-200 2u; 201-230 3u; 231-260 4u; 261-290 5u; 291-320 6u; 321-350 7u; 351-380 8u; 381-410 9u, etc.

- **CF 25:** for BG 140-165 give 1u; 166-185 2u; 186-210 3u; 211-235 4u; 236-260 5u; 261-285 6u; 286-305 7u; 306-330 8u; 331-355 9u, etc.

- **CF 20:** for BG 140-160 1u; 161-180 2u; 181-200 3u; 201-220 4u, etc. OR
  - BG 140-180 give 2u; 181-220 4u; 221-260 6u, 261-300 8u, 301 -340 10u, 341-380 12u, 381-420 14u, 421-460 18u, 461-500 18u, etc.

Example for Using Correction Insulin for Illness

- During illness aim for blood glucose in **110-180 range (target ~140)**
  - Therefore, you might use **target BG of 140** for 110-180 range
  - If high risk of low BG aim for 140-180 range (target BG 160)

- Example of Correction dose calculation for CF 30
  - [**current BG-target BG/CF**] – e.g., Current BG is 350 and target is ~140
  - 350-140/30 = 210/30 = 7u correction dose of rapid acting insulin to bring BG down 210 points
    - If this does not bring glucose down to target range – you can **strengthen the CF** to increase the correction dose: 210/**25**= 8u; 210/**20** = 10.5u; 210/**15** = 14u

  - Can give patient a **correction scale**: e.g., for BG 180-210 1u; BG 211-240 2u; BG 241-270 3u, 271-300 4u, BG 301-330 5u, etc.
    - See cheat sheet to copy and paste for different CF values

Correction Scales for different Correction Factors for Illness

- **CF 50:** for BG 180-230 give 1u; 231-280 2u; 281-330 3u; 331-380 4u; 381-410 5u; 411-460 6u; 461-510 7u, etc.

- **CF 40:** for BG 180-220 give 1u; 221-260 2u; 261-300 3u, 301-340 4u, 341-380 5u, 381-420 6u, 421-460 7u, 461-500 8u, 501-540 9u, etc.

- **CF 30:** for BG 180-210 give 1u; 211-240 2u; 241-270 3u; 271-300 4u; 301-330 5u; 331-360 6u; 361-390 7u; 391-420 8u; 421-450 9u, etc.

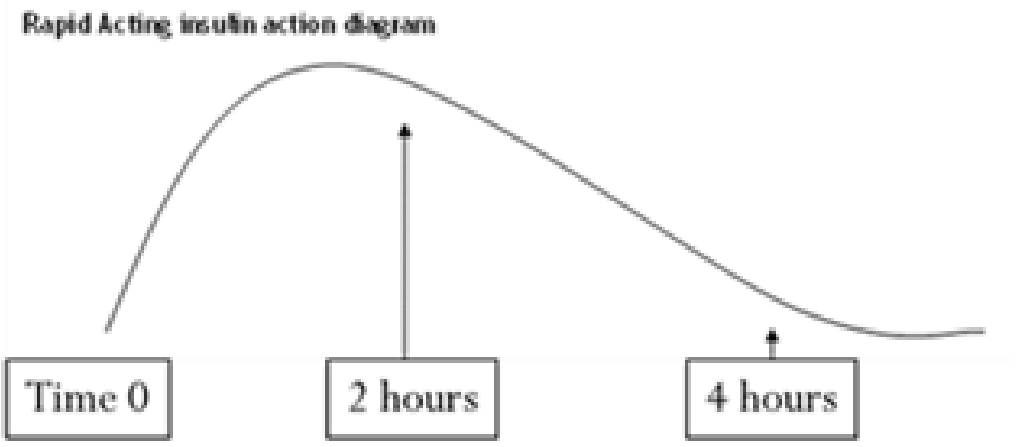
- **CF 25:** for BG 175-200 give 1u; 201-225 2u; 226-250 3u; 251-275 4u; 276-300 5u; 301-325 6u; 326-350 7u; 351-375 8u; 376-400 9u, etc.

- **CF 20:** for BG 180-200 1u; 201-220 2u; 221-240 3u; 241-260 4u, etc. OR
  - BG 180-220 give 2u; 221-260 4u; 261-300 6u, 301-340 8u, 341-380 10u, 381-420 12u, 421-460 14u, 461-500 18u, 501-540 18u, etc.

Guide for Using Correction Insulin

Only give (dose) **Correction Insulin**

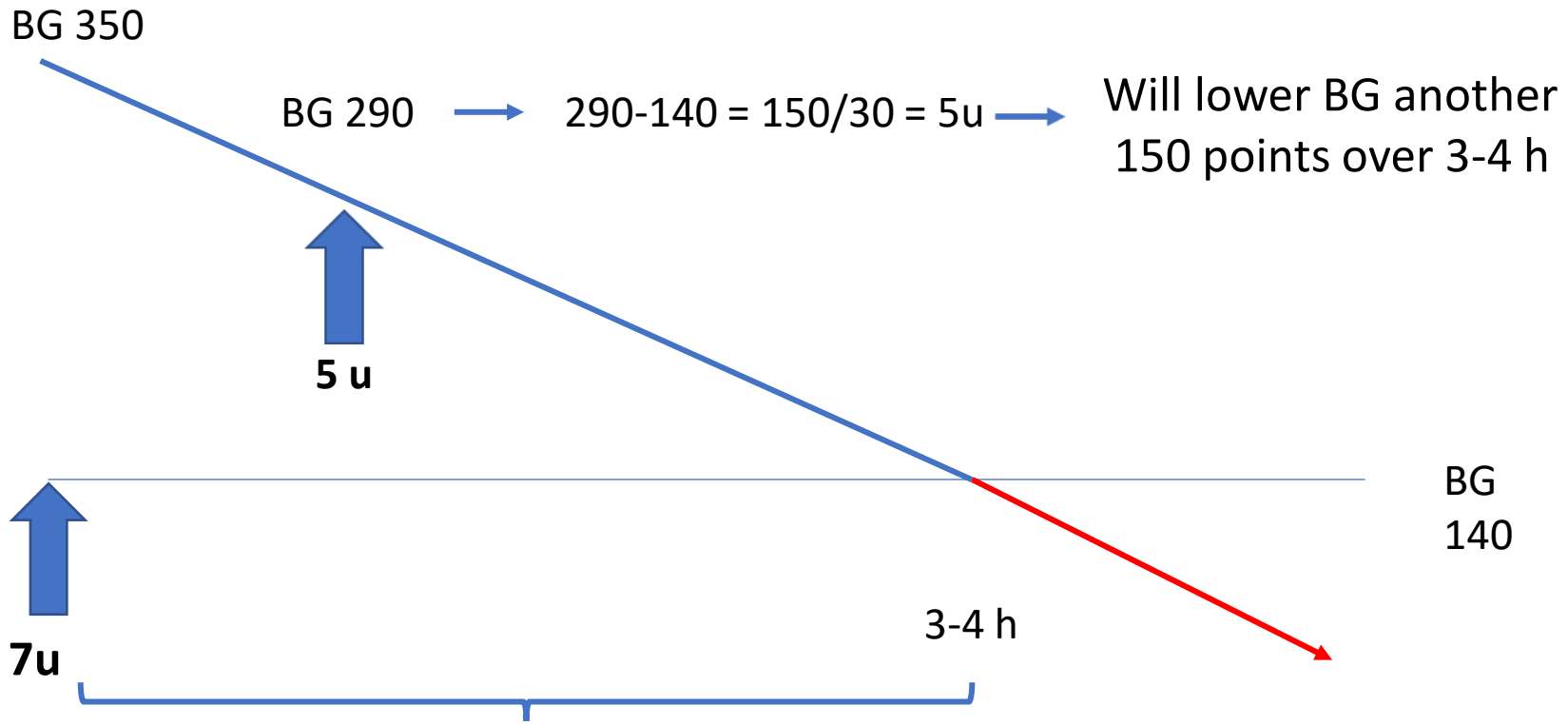
- every ***3-4 hours for analog insulin*** –
- every ***4-6 hours for Regular insulin*** –
- otherwise end up **"stacking" insulin** and risk of low BG
  - Explain it takes Fast Insulin 3-4 hours to **finish working**



Can give Meal insulin
every time you eat since
this is covering ingested carbs –
but
Correction insulin should
usually only be given
every 3-4 hours

“Stacking” Correction Doses

Correction dose: 350-140 =210/30 = 7 units

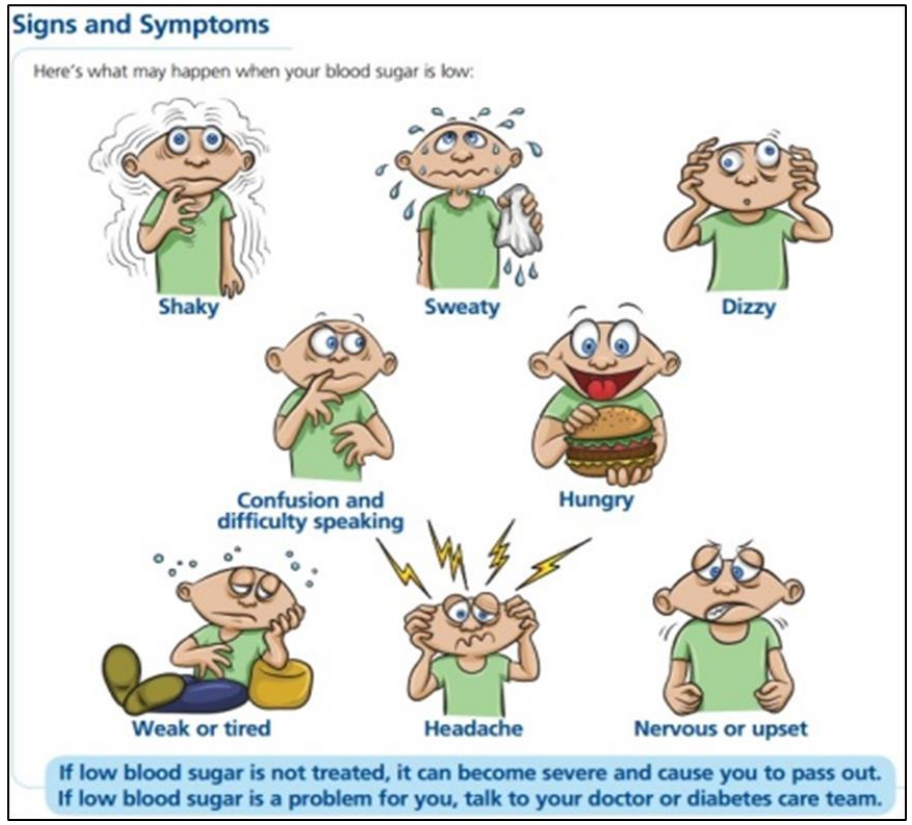


7u will lower BG 210 points over 3-4 hours

It takes an average of 4 hours for rapid insulin to *finish* working

Additional Education & Precautions

- Anytime you prescribe insulin, ensure that the patient
  - Has some means of checking their BG levels (SBGM or CGM)
  - Knows how to prevent, recognize & treat **hypoglycemia (**provide education at time of insulin initiation)



Hypoglycemia defined as blood glucose <70 for people with diabetes = "Low Blood Sugar"

ADA Hypoglycemia Recommendations

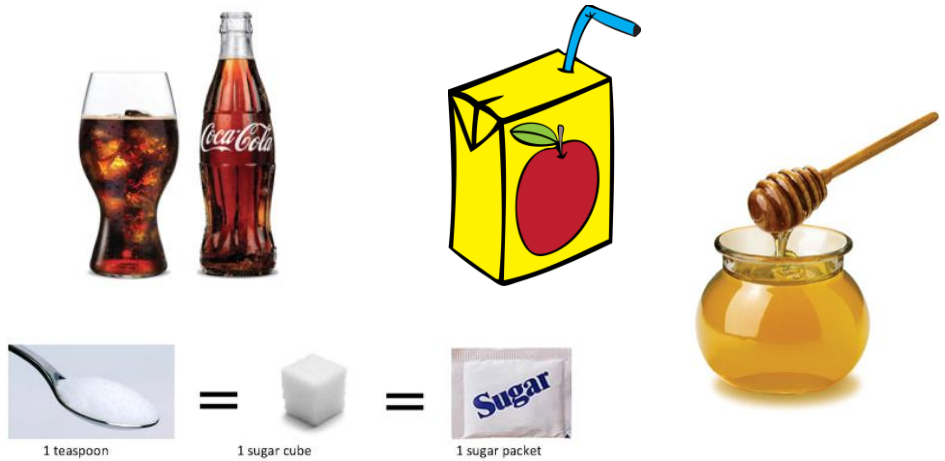
- 6.10 **Occurrence and risk for hypoglycemia** should be reviewed at every encounter and investigated as indicated. Awareness of hypoglycemia should be considered using validated tools. C *if taking meds that can cause hypoglycemia* (insulin, sulfonylureas, glinides)

- 6.11 **Glucose (approximately 15–20 g) is the preferred treatment** for the conscious individual with blood glucose <70 mg/dL, although any form of carbohydrate that contains glucose may be used.
  - Fifteen minutes after treatment, if blood glucose monitoring (BGM) shows continued hypoglycemia, the treatment should be repeated.
  - Once the BGM or glucose pattern is trending up, the individual should consume a meal or snack to prevent recurrence of hypoglycemia. B

- 6.12 **Glucagon** should be prescribed for all individuals at increased risk of level 2 or 3 hypoglycemia, so that it is available should it be needed.
  - Caregivers, school personnel, or family members providing support to these individuals should know where it is and when and how to administer it. Glucagon administration is not limited to health care professionals. E

Treating Hypoglycemia – Patient Education

- Hypoglycemia "**Rule of 15/15**"
  - 1) Check your blood glucose: If your blood glucose is 70-100mg/dL and you are symptomatic (sweaty, shaky, hungry, irritable, tired) or your blood glucose is less than 70mg/dL, take **15 grams of fast acting carbohydrates***.
    - *Examples of fast acting carbohydrates are:
    - 3-4 glucose tablets OR
    - 1 tube glucose gel OR
    - 1 cup non-fat milk OR
    - 6 oz regular soda OR
    - 4oz (1/2 cup) fruit juice OR
    - 5 lifesavers OR
    - 2 tablespoons of raisins or
    - 2 teaspoons of sugar or honey.



  - 2) **Wait 15 minutes and then recheck** your blood glucose. If your blood glucose is not up to 100mg/dL, then repeat the above treatment.
  - If the symptoms of low blood glucose are gone but it is *more than 1 hour away from your mealtime*, **eat a snack** of 1 starch and 1 protein such as ½ sandwich OR 1oz cheese and 6 crackers OR 1 tbsp. peanut butter and 6 crackers OR 4oz non-fat milk and 2 graham crackers.

Sources of Carb (want "rapid" Carbs for fast absorption)

- **Great Sources of Carbohydrate for a Low Blood Sugar**
  - *Glucose gels (cake gels) (absorbed from lining of mouth)*
    Glucose tabs
    Smarties
    Pixie Sticks
  - These are all dextrose and glucose and are broken down and in your system within 10 minutes. Dextrose is very similar to glucose in terms of it's molecular structure, which makes it a fast source of carbohydrate for a low.
- **Pretty Good Sources of Carbohydrate for a Low Blood Sugar**
  - *Juice box*
    Soda
    Dried fruit
    Jellybeans
  - These sources can take at least 20 minutes to break down and get into your bloodstream (e.g., Jellybeans have a lot of additives and fillers, which your body has to break down first, before digesting the carbohydrates)
- **Not-So-Great Sources of Carbohydrate for a Low Blood Sugar**
  - *Whole milk*
  - *Peanut Butter Sandwiches*
    Chocolate bars
    Cookies
    Ice cream
  - These sources of carbohydrates are loaded with fats and proteins, which will slow down the digestion process and delay your body's ability to get that glucose into your bloodstream.

Glucagon

Joslin Diabetes Center Patient Guide

If you pass out [from low blood sugar]

- If … you do not take care of low blood glucose, you may pass out.
- If you do, a drug called **glucagon** should be injected into your skin, like you do with insulin.
- This can be done by a family member or friend who has been taught how to do it.
- Since glucagon may cause you to vomit, you should be placed on your side when the injection is given.
- If no one knows how to give the injection, you should be taken to a hospital.
- You need a prescription for a glucagon kit.
- You should awaken about 10 minutes after the glucagon is injected. If you do not, you should be taken at once to a hospital.

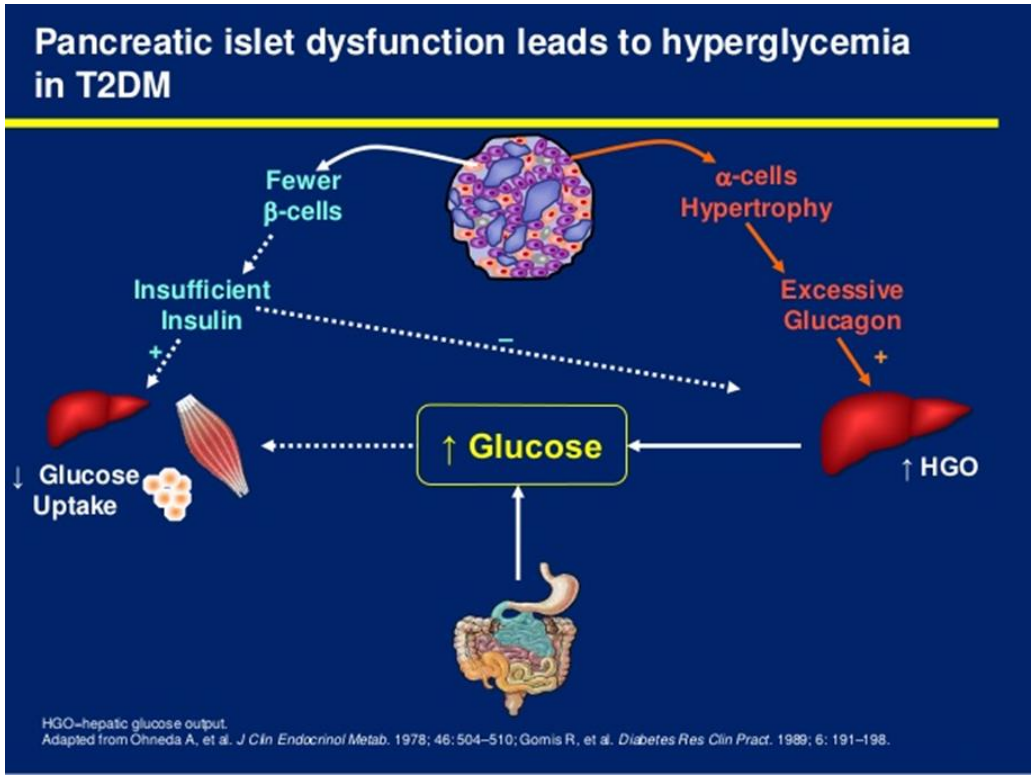
Glucagon- new formulations & delivery

- Using BAQSIMI®, Dosing & Storage | BAQSIMI (glucagon) nasal powder

- What Is Gvoke® (glucagon injection): Glucose Autojector Pen for Diabetics (gvokeglucagon.com)

Basal (fasting) Hyperglycemia

- Predominate source of excess glucose in
  - Poorly controlled Type 2 diabetes or if A1c >8%
    - Typically, if A1c is >8% and/or if TIR is <66% - high BG is due to too much basal glycemia
  - Most new onset Type 2 diabetes
    - Impaired fasting glycemia (IFG)
    - Impaired glucose tolerance (IGT)
- Excess glucose from hepatic glucose output
  - Inadequate insulin
  - Excessive glucagon
  - Excessive free fatty acid (from adipose tissue & inadequate insulin)

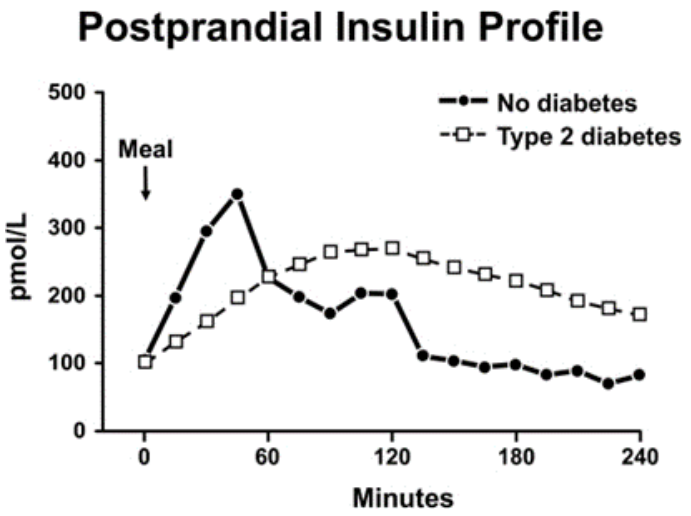


Basal (fasting) Hyperglycemia

- Most medications impact
  - **Metformin**
  - **Longer acting insulins** (Insulin direct effect on liver & on adipose tissue to reduce FFA = reduce hepatic glucose output)
  - **Sulfonyl-urea medications**
  - **TZDs**
  - **Long-acting GLP-1 Receptor agonists** (increase insulin (direct effect on liver/ reduce FFA from adipocytes) & reduce glucagon = reduced hepatic glucose output)
  - **DPP4-inhibitors**
  - **SGLT-2 inhibitors**

Postprandial Hyperglycemia

- Predominate source of excess glucose in
  - Better controlled Type 2 diabetes as A1c nears 7%
    - If A1c <8% and/or TIR >66% - target postprandial glucose
  - Longer duration of Type 2 diabetes (>10 years)
- More complex
  - Normal -rapid rise in Insulin & Amylin + gut hormones (GLP-1);
    - reduction in glucagon,
    - slowing of gastric emptying;
    - increase in satiety to reduce eating
  - Type 2 Diabetes:
    - Reduced & delayed rise and peak in insulin
    - Reduced & delayed rise and peak in amylin & gut hormones (GLP-1)
    - Gastric emptying not delayed (rapid absorption-spike)
    - Glucagon not reduced (high output of glucose from liver)
    - Satiety not enhanced (eating more)



Postprandial Hyperglycemia

- Fewer medications impact postprandial glycemia
  - Alpha- Glucosidase Inhibitors (Precose, Glyset)
  - Glinides (Starlix, Prandin)
  - Stepwise addition of **prandial insulin** (mealtime [bolus] insulin)
    - More rapidly absorbed prandial insulin
  - **GLP-1 receptor agonists**
    - GLP-1 receptor agonists provide improvements in ***both PPG and FPG levels*** because they
      - stimulate glucose-dependent insulin secretion
      - inhibit glucose-dependent glucagon secretion
      - slow gastric emptying
      - increase satiety
  - Amylin receptor agonist (Symlin (pramlintide))
  - **SGLT2i** helps reduce height of postprandial rise

Questions, Comments, Clarifications, etc.