Diabetes Mellitus Masterclass
Chapter 7

ADJUSTING INSULIN

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CORRECTING FASTING HYPERGLYCEMIA

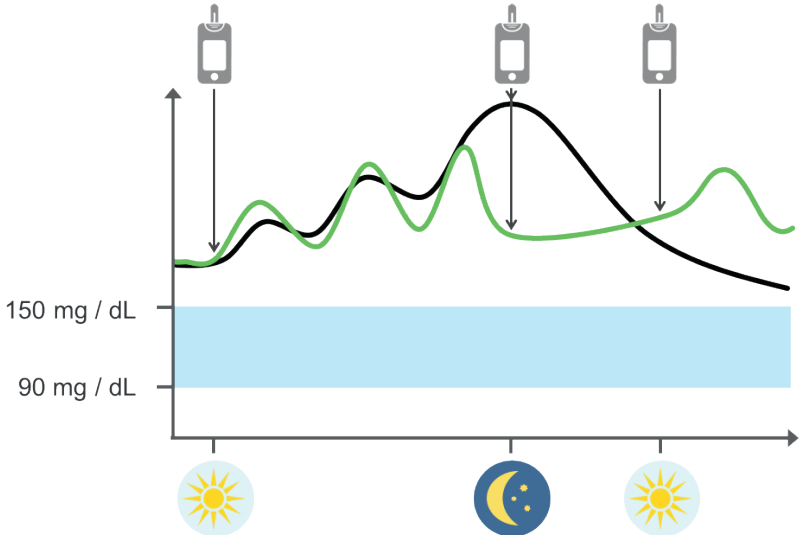
There are two main causes of fasting hyperglycemia

1. Persistently elevated blood sugars due to inadequate basal insulin (green curve below)

- Entire glucose curve shifts down with increase of basal insulin
- This brings most blood sugars into range

2. Post-meal hyperglycemia due to inadequate mealtime insulin (black curve below)

- Blood sugars are increasing throughout the day (going up with meals)
- Blood sugar drops significantly overnight due to high doses of basal insulin
- If you increase basal coverage you would get normalization of fasting blood sugars but also increase the risk of hypoglycemia in the fasting state
- Increase mealtime insulin to bring all blood sugars closer to goal



If your patient is **only checking fasting blood sugars**, you won't be able to distinguish between these two patterns, since fasting blood sugars are similar in both cases. If patients have fasting hyperglycemia, they need to **check twice daily**—before breakfast and at bedtime—to help determine the cause.

- If blood sugars are **stable** or **increadsing** overnight (green curve above)—patient needs more basal insulin
- If blood sugars are **dropping** > 50 mg / dL overnight (black curve above)—patient needs more mealtime insulin

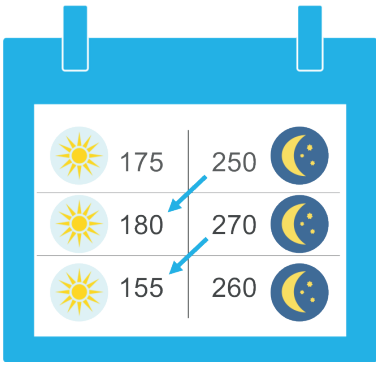
Example

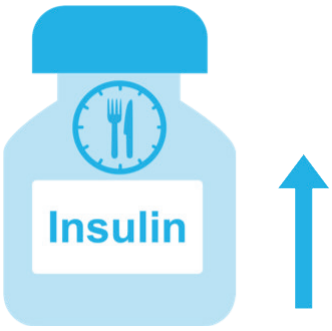
Meet Mr. H

Mr. H checks his blood sugars every morning and has elevated fasting blood sugars.

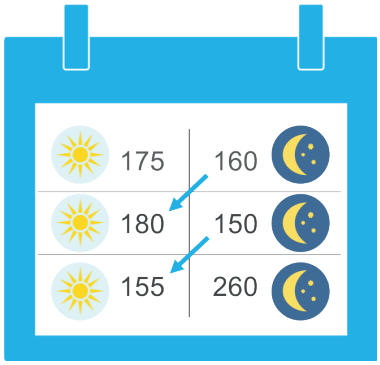
You ask him to complete a three day glucose log, checking fasting and bedtime blood sugars.

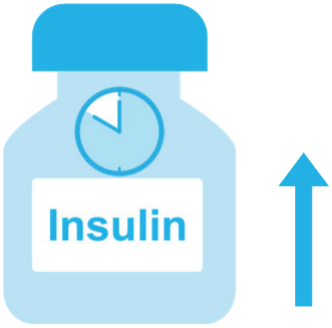
His bedtime blood sugars are markedly elevated, and decrease overnight.
The best choice for him would be to increase his mealtime insulin coverage.





If the log instead showed blood sugars that were stable or increasing overnight, you would increase his basal insulin to provide better overnight glucose control.





ADJUSTING MEALTIME INSULIN

To safely adjust mealtime insulin, patients need to be checking blood sugars multiple times daily—before and 1–2 hours after meals. There are several ways to accomplish this.

- Three day glucose log with seven checks per day (before and after each meal and at bedtime)
- One month glucose log with two checks per day
  - week 1—before and after breakfast
  - week 2—before and after lunch
  - week 3—before and after dinner
  - week 4—bedtime and before breakfast

If postmeal blood sugars are > 180 mg / dL, you should adjust mealtime insulin.

If the patient is on one dose of mealtime insulin daily

- Increase dose of mealtime insulin with that meal by 2 units
- Continue to increase dose every 2–3 days until post-meal blood sugar is < 180 mg / dL
- If A1c remains elevated add additional mealtime insulin doses

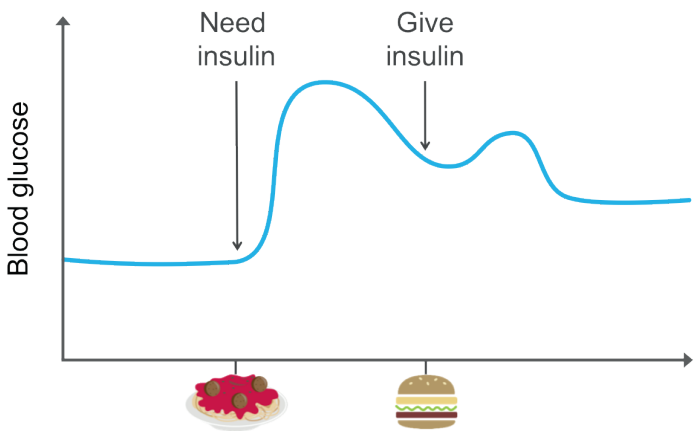
If patient is on multiple doses of mealtime insulin daily

- Adjust dose for one meal at a time (start with largest meal of the day)
- Consider decreasing basal insulin dose as mealtime insulin is increased (to prevent fasting hypoglycemia)

There are three roles for insulin—basal coverage, mealtime coverage, and correction for elevated blood sugars. Correction insulin should rarely be used without scheduled mealtime insulin.

Problems with correction (or sliding scale insulin)

- Patients only take insulin if blood sugars are elevated
- Does not prevent post-meal hyperglycemia
- Insulin has to work *backwards*—correcting post-meal hyperglycemia rather than preventing it



AVOIDING HYPOGLYCEMIA

Hypoglycemia is one of the most serious side effects of insulin therapy.

Symptoms of hypoglycemia include

- Palpitations
- Sweating
- Nausea
- Confusion
- Loss of consciousness
- Seizures

For patients with hypoglycemia, it is important to characterize these events in order to help prevent them.

Questions to ask

- Do they occur overnight or when fasting?
- Do the patient's blood sugars drop low if they go too long without eating?
- Are episodes happening shortly after eating?
- Does hypoglycemia occur with exercise?

Each of these situations requires a different approach.

Overnight or fasting hypoglycemia

- Often results from too much basal insulin
- Solution
  - decrease basal insulin by 10–20%

Daytime hypoglycemia (occurring with missed meals)

- Too much basal insulin
- Solution
  - decrease basal insulin by 10–20%

Daytime hypoglycemia, 1–2 hours following a meal

- Likely due to too much meal time insulin
- Evaluate cause
  - inaccurate carbohydrate counting
  - poor appetite and inconsistent food intake

- Solutions
  - inaccurate carbohydrate counting—education, adjust insulin dose based on meal size
  - poor appetite—take insulin **after** meal and adjust dose based on amount eaten

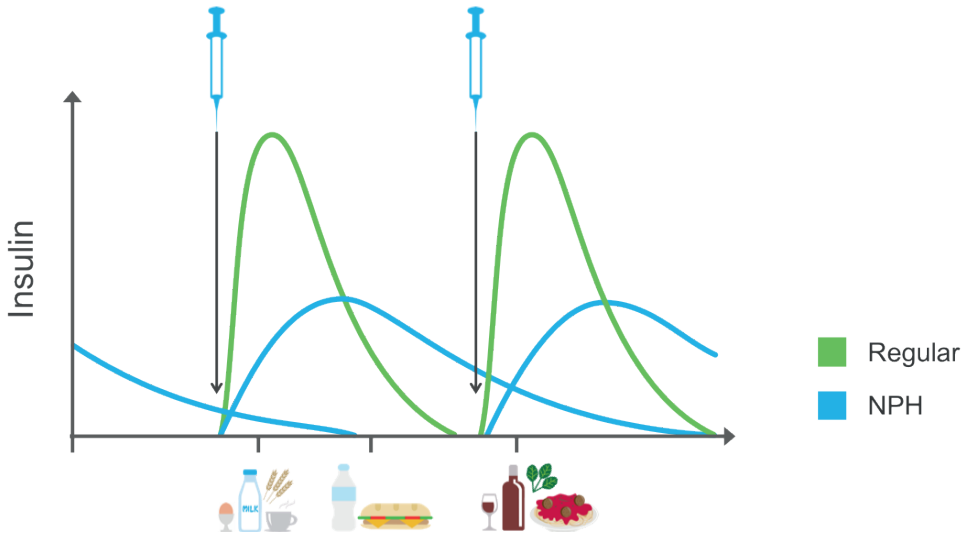
Exercise associated hypoglycemia

- Due to improved insulin sensitivity with exercise
- Solution
  - decrease insulin with meal prior to exercise or eat prior to exercise to increase pre-exercise blood sugars

MANAGING NON-COMPLIANCE

Patients who are non-compliant with their insulin treatment often benefit from simpler regimens. One way to accomplish that is with premixed insulin formulations.

Premixed insulins are combinations of **NPH insulin** and **fast-acting insulin** (regular, or one of the analog mealtime insulins) in a **single** vial that allow patients to get both types of insulin in a single injection.

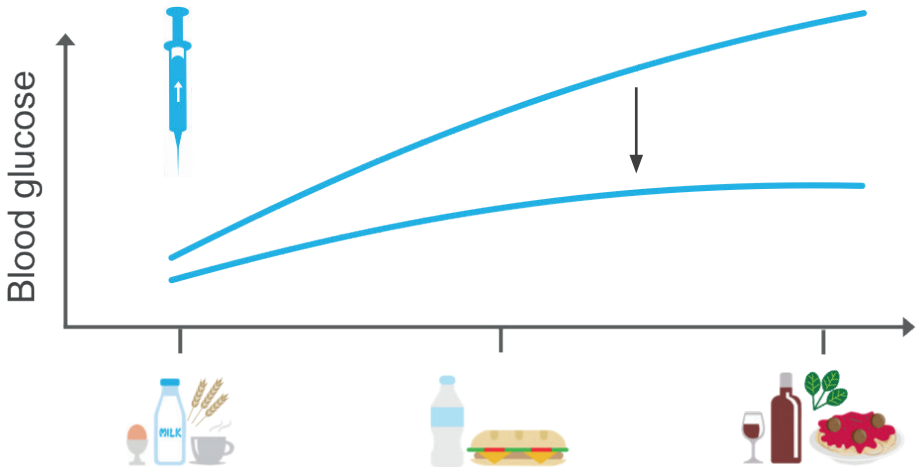


How to use premixed insulin

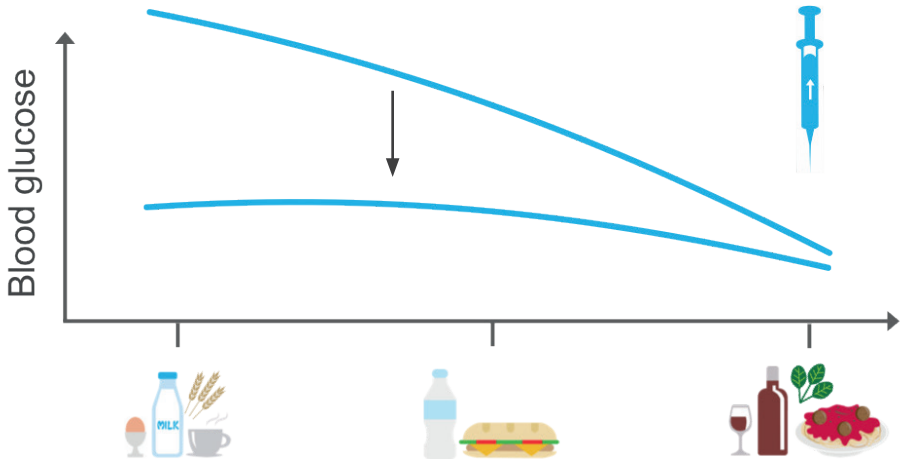
- Calculate total daily insulin dose
- If dinner is largest meal of the day—divide into 2 equal doses taken before breakfast and before dinner
- If breakfast or lunch are larger meals—take 2/3 total dose before breakfast and 1/3 dose before dinner

Adjusting premixed insulin

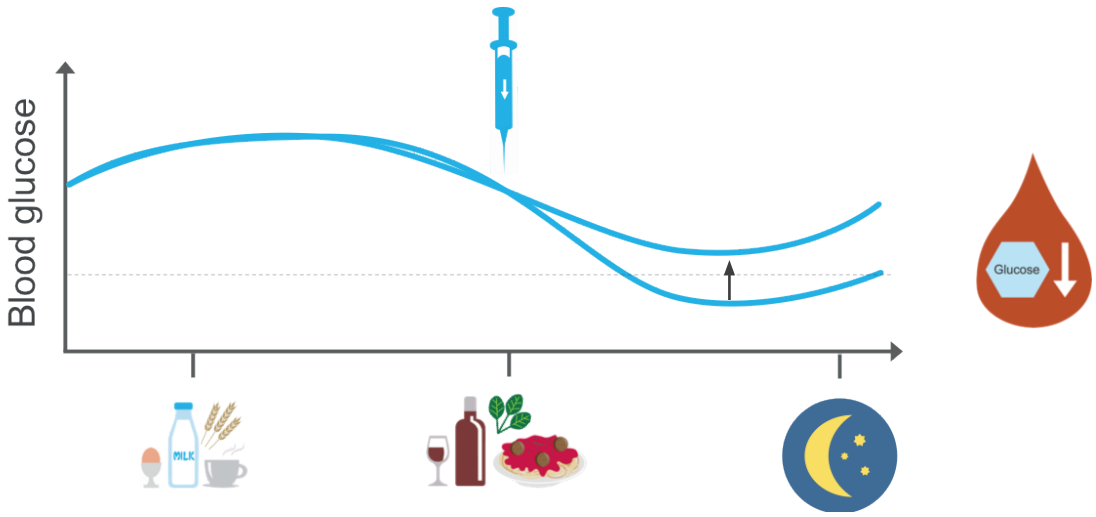
If blood sugars before dinner are running high, increase the breakfast dose of insulin.



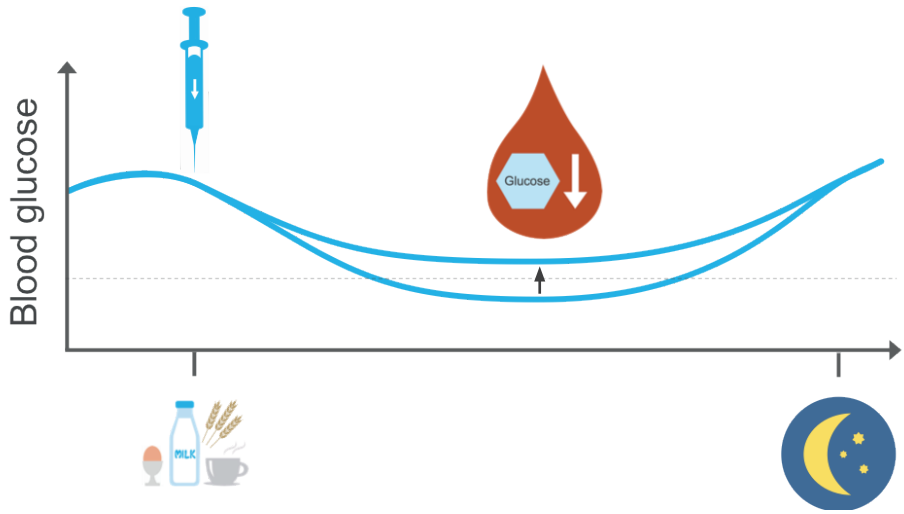
If morning blood glucose values are elevated, increase the evening insulin dose.



If the patient is having low blood sugars overnight, decrease their predinner insulin dose.



If lows are happening during the day, decrease the morning insulin dose.

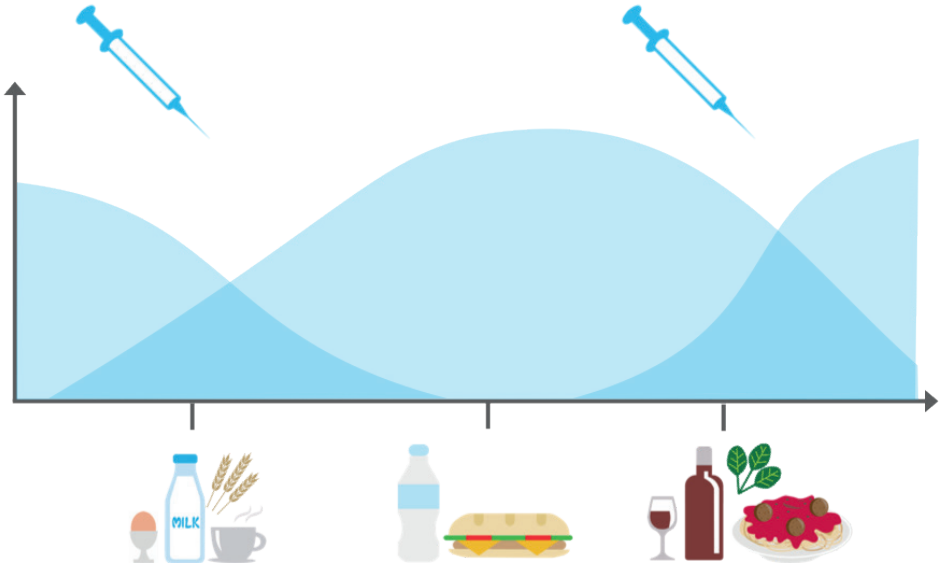


USING LOWER COST INSULINS

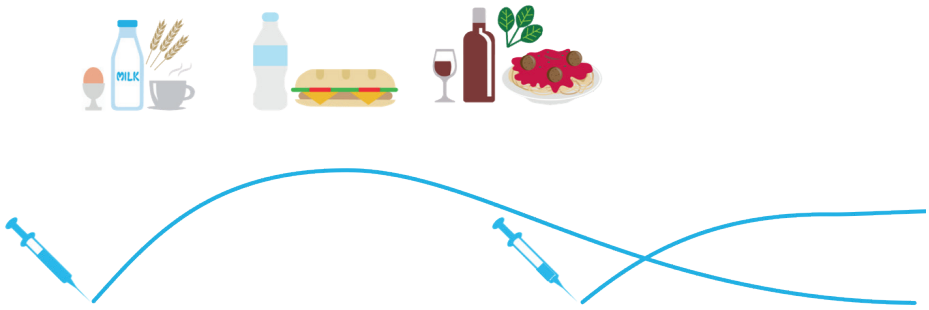
Insulin cost is a significant barrier for many patients. Understanding how to use the lower cost NPH and regular insulins can be helpful in these situations.

Low-cost basal insulin—NPH

NPH acts as a basal insulin when given twice daily.



- To transition from analog insulin calculate total basal insulin dose
- Give 2/3 dose before breakfast and 1/3 dose at dinner



- If fasting blood sugars are elevated increase evening NPH dose
- If predinner blood sugars are elevated increase morning NPH dose
- If patient is having overnight hypoglycemia move evening NPH dose to bedtime

Low-cost mealtime insulin—regular insulin

Regular insulin has a short duration of action, but longer time to onset compared to analog insulins.

- To transition from analog insulin similar doses can be used before meals
- Must be given 30 minutes prior to meal
- Can be mixed in same syringe as NPH to minimize number of injections

READING LIST

Practical guide to insulin adjustments

LaSalle, JR and Berria, R. 2013. Insulin therapy in type 2 diabetes mellitus: a practical approach for primary care physicians and other health care professionals. *J Am Osteopath Assoc.* **113**: 152–162. https://www.ncbi.nlm.nih.gov/pubmed/23412677

Using lower cost insulins

Lipska, KJ, Hirsch, IB, and Riddle, MC. 2017. Human Insulin for Type 2 Diabetes: An Effective, Less-Expensive Option. *JAMA.* **318**: 23–24. https://www.ncbi.nlm.nih.gov/pubmed/28604935

Tylee, T and Hirsch, IB. 2015. Costs Associated With Using Different Insulin Preparations. *JAMA.* **314**: 665–666. https://www.ncbi.nlm.nih.gov/pubmed/26284715