Inpatient Diabetes Management- from Admission to Discharge

Jeayoung Park, IM-PGY2

First of all, thank you

Hello all,

Thank you so much for filling out the survey for the
be able to help us out if you haven't already?
I'm sorry to bother you all on a weekend.

https://forms.gle/4vm5S7VPgGrNZoqe7

Sincerely,
Jeayoung Park

Hello all, I'm really sorr
you be able to help out
need it for noon confer

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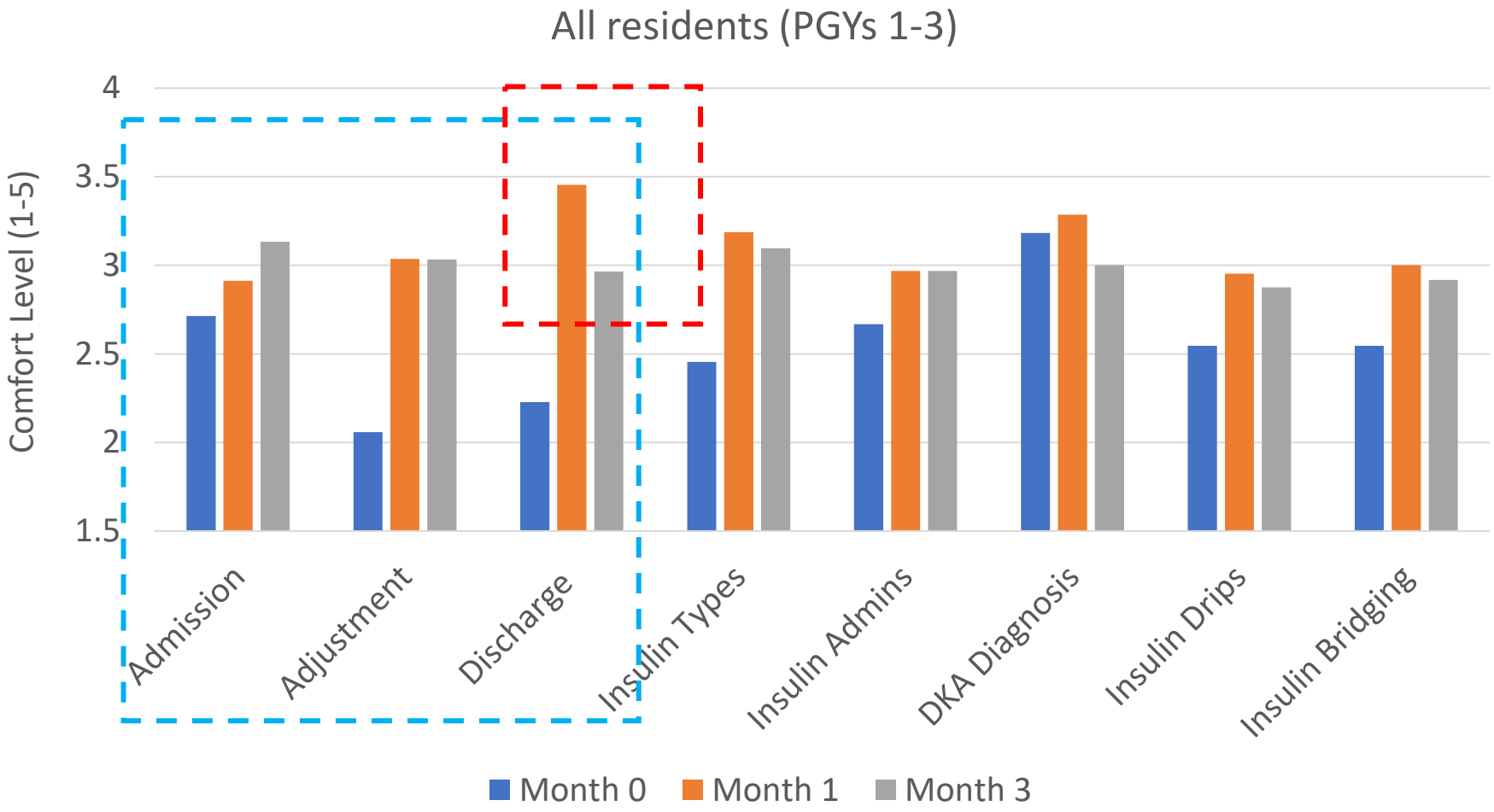
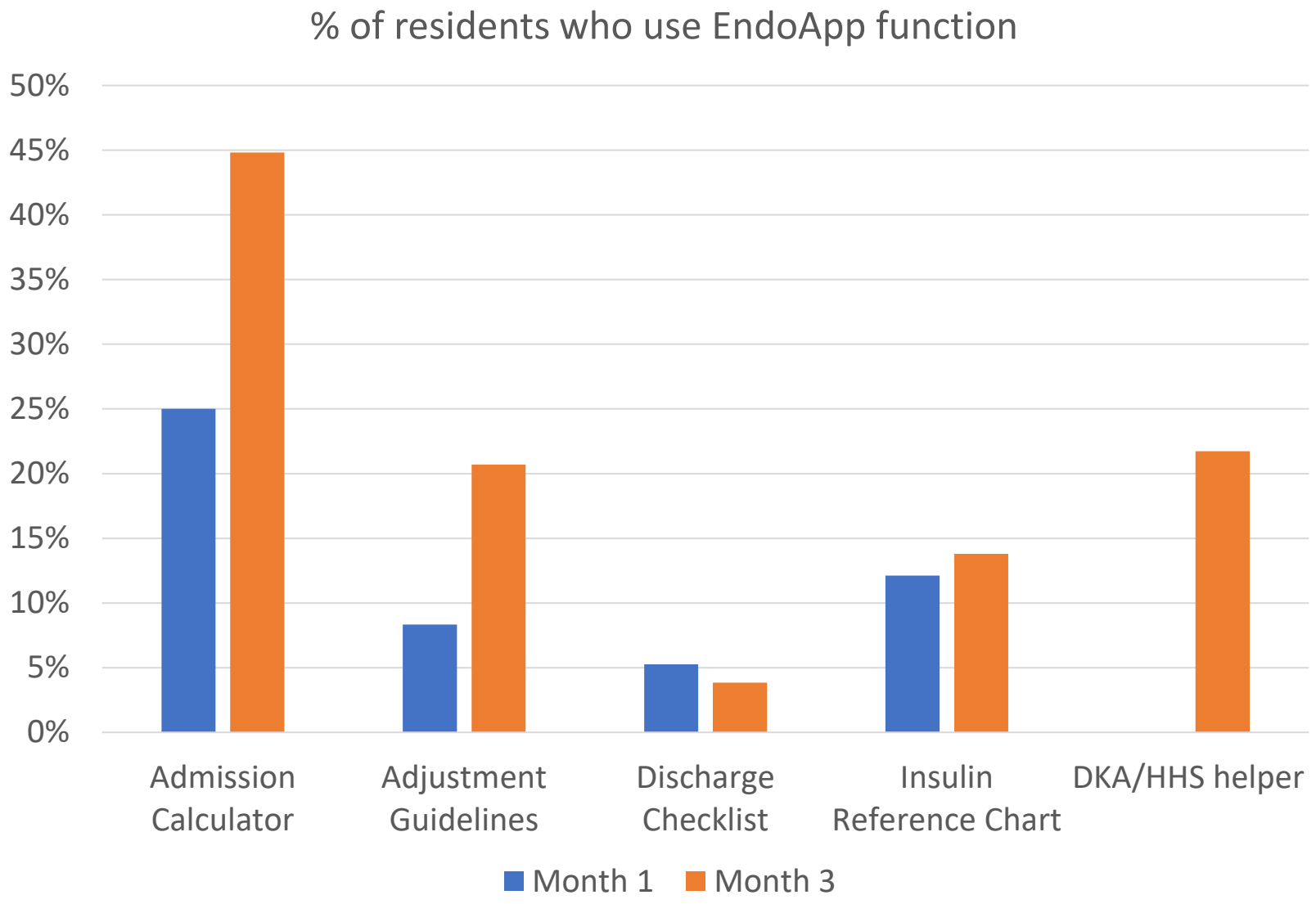
1:51 PM 26 days left

Your Responses



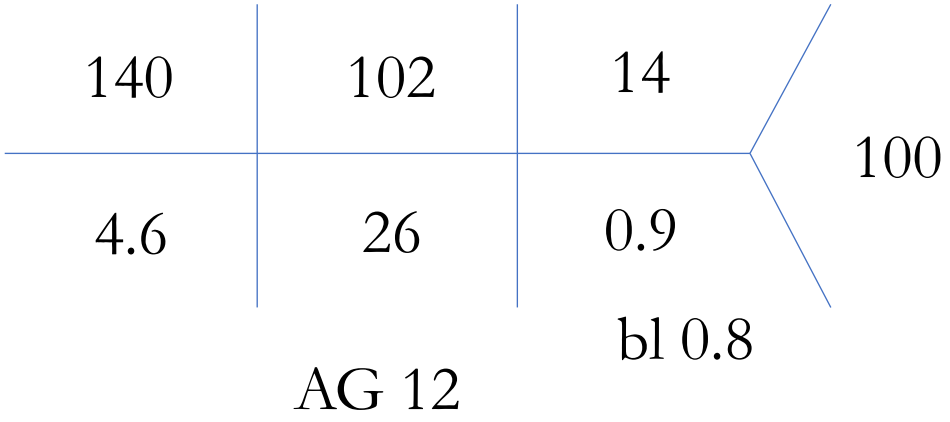


	Month 1	Month 3
Admission Calculator	25%	45%
Adjustment Guidelines	8%	21%
Discharge Checklist	5%	4%
Insulin Reference Chart	12%	14%
DKA/HHS helper	0%	22%

Case- Admission

57 year old female with PMH of obesity (BMI 73), complete heart block s/p pacemaker (2018), Afib, pulm HTN, chronic DVT/PE on warfarin, T2DM (A1c 7.8, on glargine 30 units, aspart 10 units TID, and metformin 500mg BID since 2019), sarcoidosis. Patient is admitted for shortness of breath, found to have afib with RVR.

Patient is tachycardic, but normotensive. BMP is as follows:



Q. Would you start the patient on insulin?

A. Yes. Since patient has been maintained on subcutaneous insulin for a long time-- patient is insulin resistant and possibly insulin dependent (decreased production) as well.

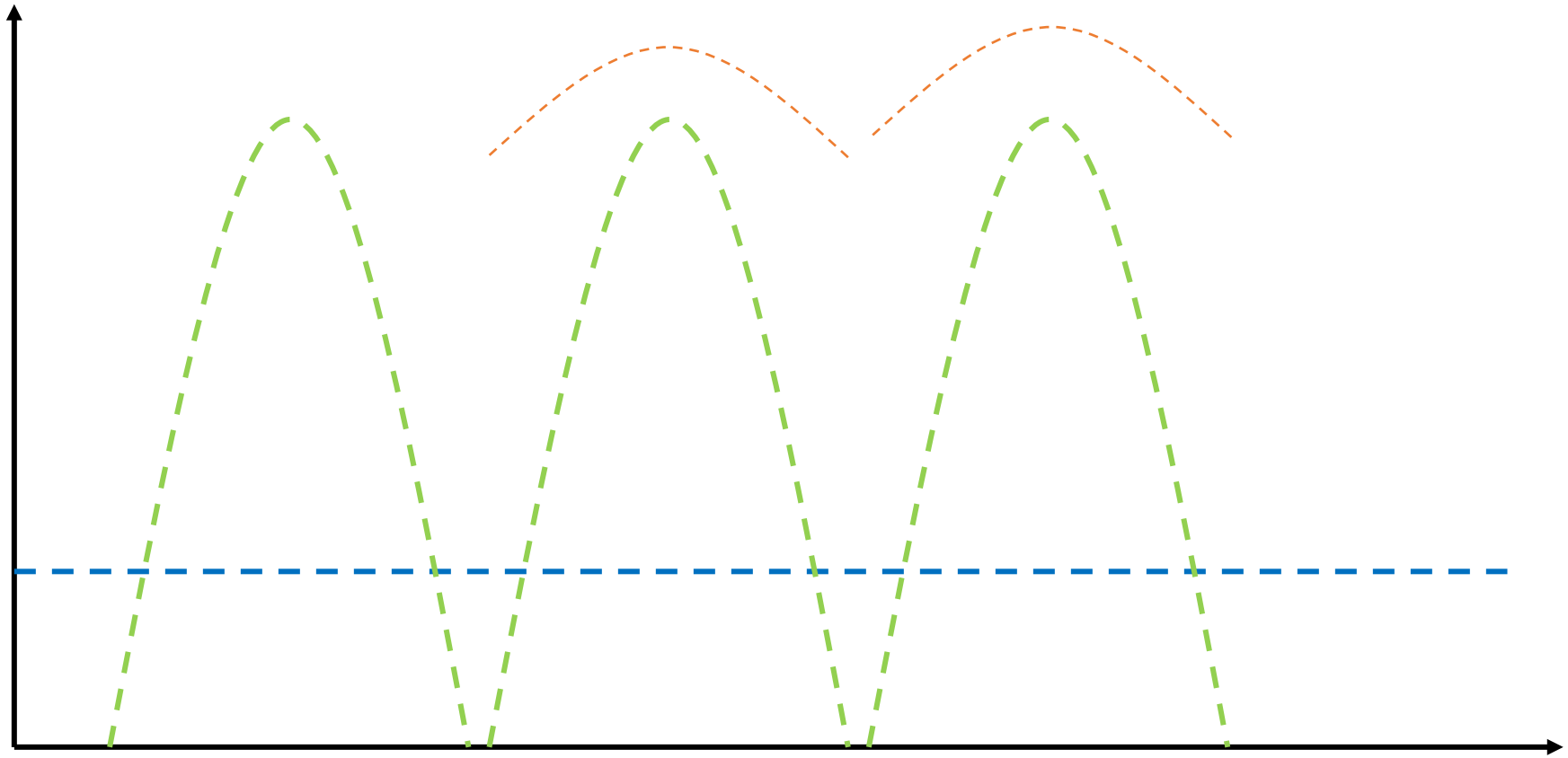
You notice again that the patient's blood glucose is **100mg/dL**, which is lower than the inpatient goal of 140-180mg/dL per the NICE-SUGAR trial.

Q. Should the patient be on a basal-bolus regimen or a sliding-scale only regimen?

A. Sliding-scale only regimens do not "control" glucose levels, because they are a reactive treatment for hyperglycemia that has already happened.
(Kodner et al., *Am Fam Physician* 2017)

Sliding scale only regimens are known to have a higher mean daily glucose concentration, and have increased rates of wound infection, pneumonia, bacteremia, etc. (RABBIT-2 Surgery Trial).

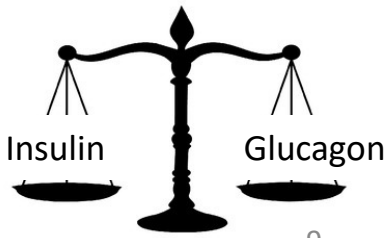
Basal, Prandial, and **Correctional** Insulin together simulate the body's natural insulin production.



Correctional Insulin:
Simulates the extra insulin secretion when the patient is hyperglycemic

Prandial Insulin:
Simulates the insulin secretion from the pancreas following oral intake.

Basal Insulin:
Opposes the baseline actions of glucagon while fasting, maintaining normoglycemia



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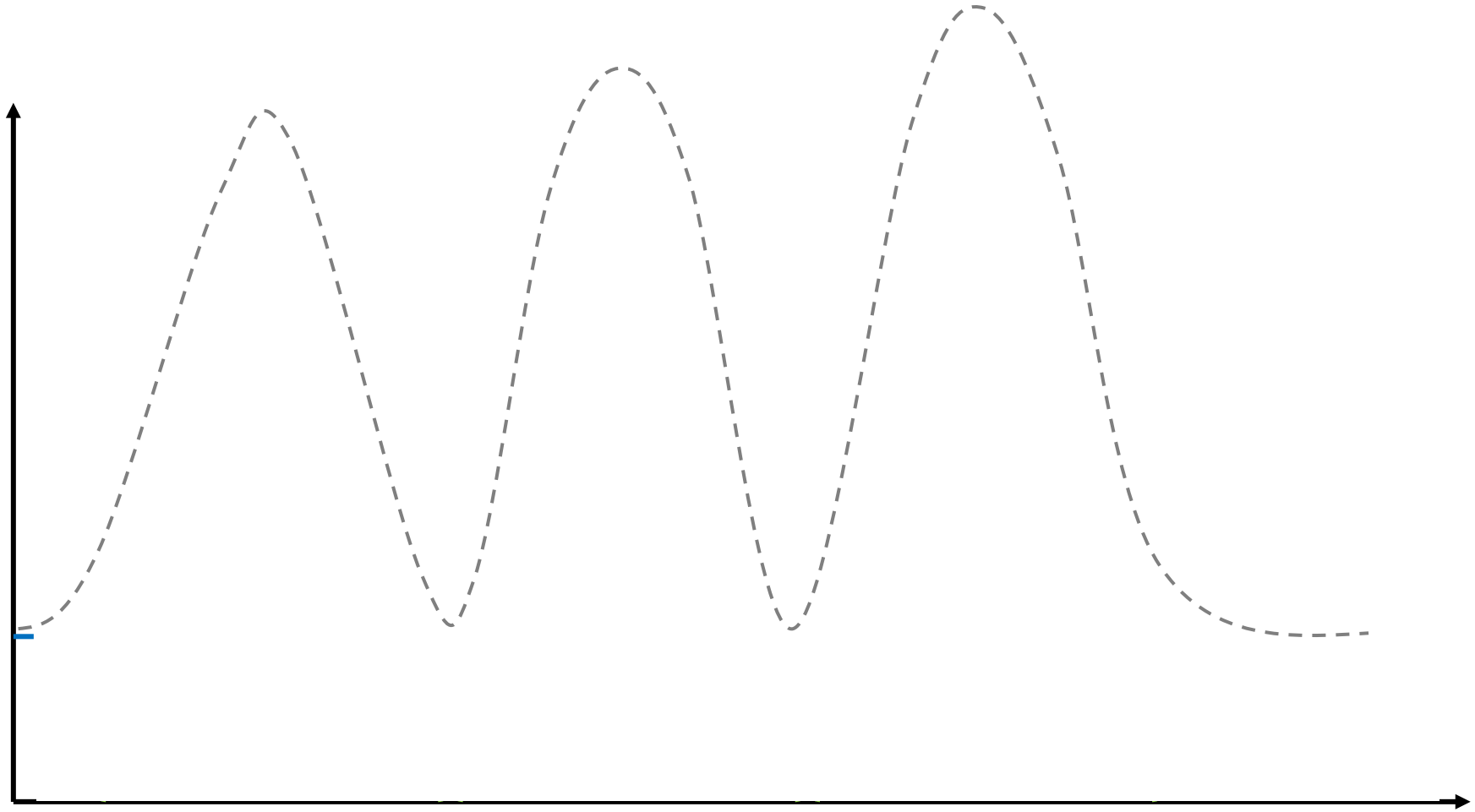

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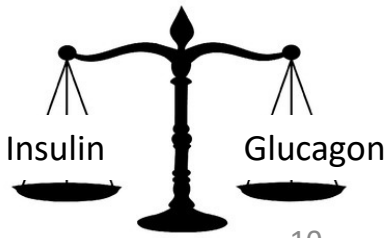


You note that the patient's outpatient regimen is glargine 30 units, aspart 10 units TID, and metformin 500mg BID. Last A1c on this regimen was 7.8.

Q. How would you dose the basal-bolus regimen?

A. Since her outpatient regimen is known to us, and the patient's A1c is reasonably controlled (7.8) on this regimen, the patient's outpatient regimen should be our basis.

Outpatient regimen with good glycemic control and compliance	→	Start inpatient regimen based on **outpatient regimen**
Unknown outpatient regimen or poor compliance	→	Start **weight-based dosing** of inpatient insulin

If dosing based on the outpatient regimen,
typically the outpatient regimen is started at a 20-30% decreased dose at admission because

1) patients tend to eat healthier in the hospital, and

2) inpatient goals are 140-180mg/dl, which is looser than outpatient goals of 80-120mg/dl.

e.g. glargine 30 units, aspart 10 units TID as outpatient
➔ glargine 24 units, aspart 8 units TID as inpatient.

Q. What if we didn't know the patient's baseline insulin regimen?

Calculate the estimated total daily dose (TDD) by weight-based dosing. (0.4 u/kg or 0.5 u/kg if obese)

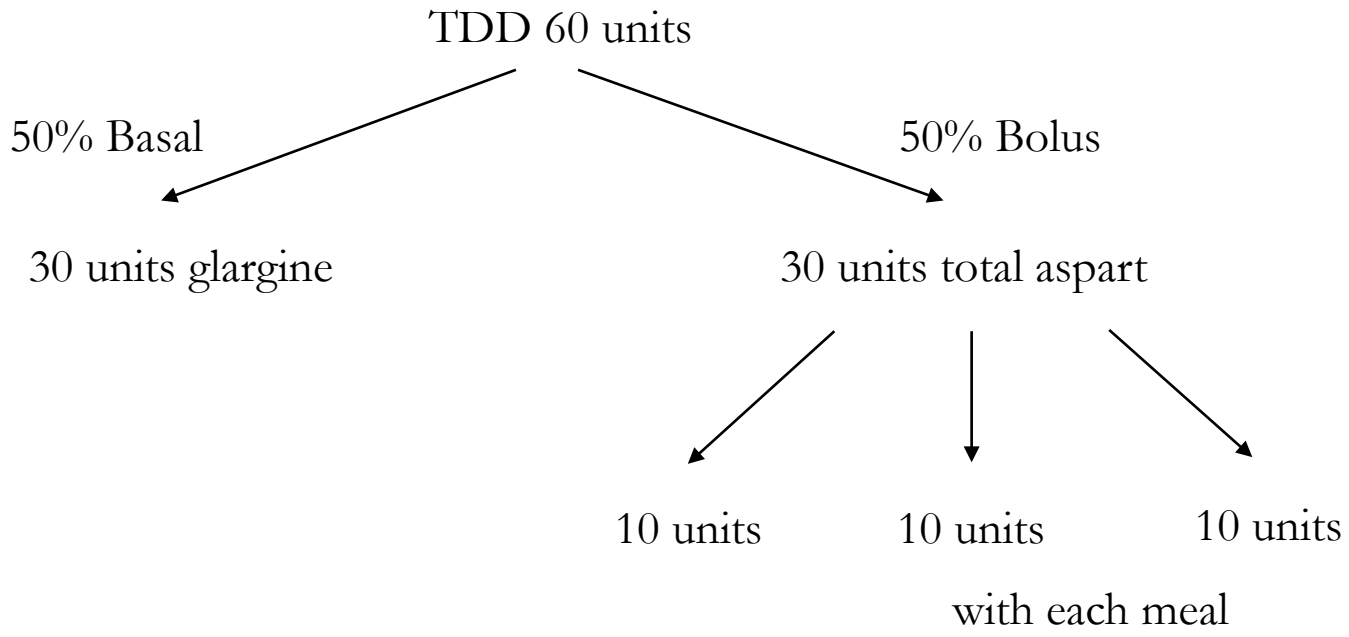
-> TDD = 120kg * 0.5u/kg = 60 units total.

Table 3. Determining Total Daily Dose of Insulin for Insulin-Naïve Hospitalized Patients with Type 2 Diabetes Mellitus

Patient characteristics	*Estimated total daily dose (units per kg)*
Normal weight	0.4
Stage IV chronic kidney disease not on dialysis	0.25
Underweight, older age, or hemodialysis	0.3
Overweight	0.5
Obese, insulin resistant, or taking systemic glucocorticoids	≥ 0.6

NOTE: *Glargine (Lantus) and detemir (Levemir) are the preferred agents, and glargine is favored because of its longer duration and once-per-day administration.*[30]

Information from references 7 and 30.



Q. What other questions would you ask before starting insulin as inpatient? (e.g. What factors can affect insulin requirement in the hospital?)

1) Will the patient be eating? Or will the patient be NPO?

-> When patients are eating but has a poor appetite, basal and pradial insulin doses are often decreased by 20-50% based on physician comfort.

-> If NPO, AFP recommends decreasing the basal insulin by **50%**, and **holding prandial insulin**

2) What is the patient's kidney function?

-> There are no clear ADA/AAFP guidelines, but in case of declining kidney function, all forms of insulin (basal, prandial) should be decreased- anywhere from 20-50%.

3) Will the patient be started on glucocorticoids?

4) Will the patient be started on tube feeds?

-> Both scenarios increase insulin resistance, and dosing is a bit different. More to discuss.

<Example 1>

Patient is on 20 units of glargine with sliding scale only at home with good control.
Patient has severe AKI.

=> Would start his home regimen, but given his AKI, dose should be decreased, ~10 units glargine is around 50%.

<Example 2>

Patient is newly diagnosed with an A1c of 13.0. Patient's weight is 108kg and BMI is 35.

Kidney function is normal and patient will be eating.

⇒ TDD = 108 kg * 0.5u/kg = 54 units
⇒ Glargine 27 units + Aspart 9 units

<Example 3>

Same patient as Example 2, but patient will undergo surgery.

⇒ Decrease glargine to 13-15 units, hold Aspart

Patient is not pending any surgery and will be eating a regular diet, will not be started on steroids, kidney function is normal.

You start her on a 20% overall decreased dose of insulin at 24 units of glargine and 8 units of novolog TID-AC, given her poorer appetite.

You also specify that if the patient *were* to go to surgery, the prandial novolog should be held.

Q. What kind of correctional insulin would you use?

A. The sliding scales known as "low-dose," "medium-dose," and "high-dose" are based on the Insulin Sensitivity Factor:

Definition- How much decrease in glucose do you expect with 1 unit of short-acting insulin?

$$ISF = \frac{1500\ or\ 1800}{Total\ Daily\ Dose\ of\ Insulin}$$

Low-Dose SSI => ISF of 1:60
Medium-Dose SSI => ISF of 1:40
High-Dose SSI => ISF of 1:20

Choose the SSI that is closest to your ISF.
e.g. If ISF is 1:42, choose a MDSSI.

<Example 1>

Glargine 15 units, Aspart 4 units TID

=> Total daily dose of **27** units

=> ISF = 1800/**27** = 66.7

=> Closest SSI to 1:66.7 is LDSSI which is 1:60

<Example 2>

Glargine 24 units, Aspart 8 units TID

=> Total daily dose of **48** units

=> ISF = 1800/**48** = 37.5

=> Closest SSI to 1:37.5 is MDSSI which is 1:40

<Example 3>

Glargine 60 units, Aspart 20 units TID

=> Total daily dose of **120** units

=> ISF = 1800/**120** = 15

=> Closest SSI to 1:15 is HDSSI which is 1:20

For simplicity,

TDD <36 units: LDSSI
TDD 36-72 units: MDSSI
TDD >72 units: HDSSI
At our hospital.

Correctional insulin can be given using a low-, intermediate-, or high-dose correction scale. A low-dose scale is appropriate if a patient's total daily dose is 20 to 42 units, whereas a moderate-dose scale is used for 43 to 84 units, and a high-dose scale is used for 85 to 126 units.[9-11]

<- AAFP guidelines

On top of the 24 units of glargine and 8 units of novolog TID-AC, you start a medium-dose sliding scale based on her Insulin Sensitivity Factor.

Q. Would you continue her metformin as inpatient?

A. In clinically stable patients, there is no good evidence to support routinely stopping metformin.

However, the risk of lactic acidosis does increase with declining renal function or with contrast media-induced nephropathy, and a dose-reduction is likely necessary.

Current guidelines are inconsistent regarding the use of metformin in the hospital.
(Kodner et al., *Am Fam Physician* 2017)

Inpatient use of SGLT-2 inhibitors and GLP-1 agonists are also an evolving subject.

<Summary- **Admission Insulin**>

- A sliding-scale only regimen does ***not*** prevent hyperglycemia and does not improve outcomes.
- Patients with a known insulin regimen with good control should start dosing based on their outpatient regimen.
- Patients with unknown regimen or poor compliance can use weight-based dosing.

- NPO status and AKI demand a **decrease** in insulin doses.
- Steroids and Tube feeds often require an **increase** in insulin doses.
- Sliding scale regimens are based on the Insulin sensitivity factor.
- Oral antiglycemics are mostly held at admission.

Case 1- continued

"The Plot Thickens"

The next morning you see that the 6AM morning glucose is 380. The following is the glucose trend:

	Breakfast	**Lunch**	**Dinner**	**Nighttime**
11/1/2021	103	114	172	241
11/2/2021	380			

Q. What is the first thing you should do?

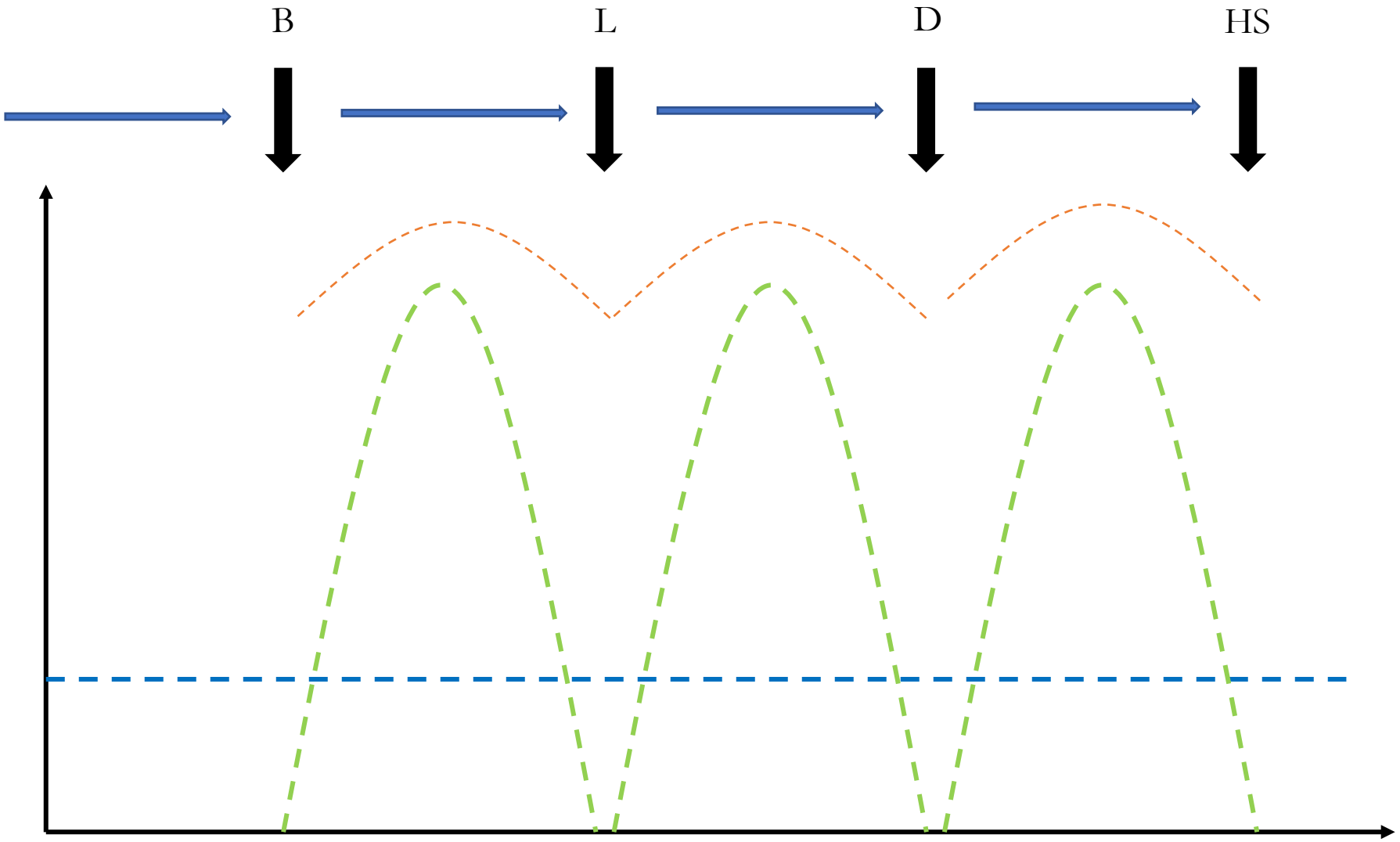
A) Change sliding scale insulin to high dose sliding scale
B) Increase basal glargine dose because a high fasting morning glucose means that the basal dose is inadequate
C) Ask the patient if they had a nighttime snack (or ask the RN)
D) Call urgent Endocrinology consult.

Q. What is the first thing you should do?

A) Change sliding scale insulin to high dose sliding scale
B) Increase basal glargine dose because a high fasting morning glucose means that the basal dose is inadequate
C) Ask the patient if they had a nighttime snack (or ask the RN)
D) Call urgent Endocrinology consult.

A is wrong, because sliding scale insulin is reactive and does not prevent hyperglycemia. Sliding scale insulin is based on the patient's insulin sensitivity factor.
B would be correct if the patient were truly fasting.
C is the correct answer. Our diet orders often default to "Allow PM snacks." Even when the diet order says carb consistent diet, oftentimes patients eat high-carb snacks and carbonated sodas at night. One must make sure the orders are not carb consistent (limiting carb intake to 60g) in the first place.
D is wrong because there is no urgency for hyperglycemia that is not DKA/HHS.

Fingerstick Glucose Value = (Last food intake) – (Last dose of insulin)



Morning fasting glucose is reflective of basal insulin

<Example 1>

Q. Where's the issue?

	Breakfast	**Lunch**	**Dinner**	**Nighttime**
Day 1	132	210	170	150
Day 2	80	102	96	

Will likely have to decrease basal insulin. However, one must ask whether the patient is eating poorly, getting insulin at the wrong time, or if the renal function is declining.

<Example 2>

	Breakfast	**Lunch**	**Dinner**	**Nighttime**
Day 1	132	210	230	84
Day 2	140	180	190	72

It may be that the dinnertime novolog is too much– but at the same time one must ask whether the patient is persistently skipping dinner.

Our patient had a significant concern for cardiac sarcoidosis– patient was started on 60mg of prednisone daily on 11/2/2021. The following is the subsequent glucose trend:

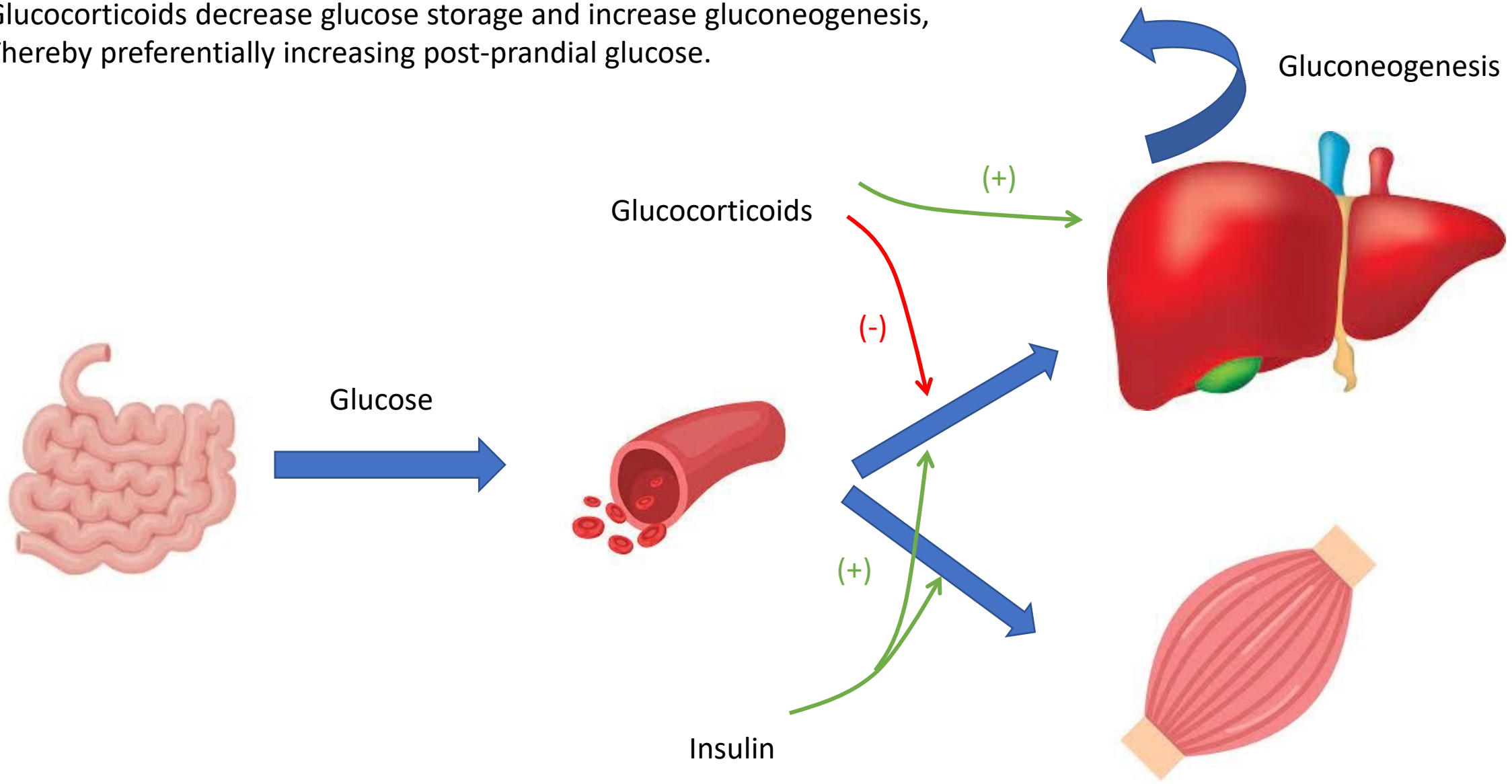
	Breakfast	**Lunch**	**Dinner**	**Nighttime**
11/2/2021	380	247	176	256
11/3/2021	271	309	341	365
11/4/2021	394	364	340	

You consult Endocrinology for concern of steroid-induced hyperglycemia.

Q. What components of the regimen would be increased?

A) Basal glargine only
B) Prandial insulin only
C) Both basal and prandial insulin, but more basal glargine increase than prandial aspart increase
D) Both basal and prandial insulin, but more prandial aspart increase than basal glargine increase

Glucocorticoids decrease glucose storage and increase gluconeogenesis,
Thereby preferentially increasing post-prandial glucose.



In steroid-induced hyperglycemia, you often see regimens of 40% basal, 60% bolus, or even high prandial components such as 25% basal, 75% bolus being used.

40% basal, 60% bolus is the initial starting regimen recommended by the AFP.

Protocols for adjusting insulin for steroids are not standardized. Typically, per every 10 mg of prednisone, the TDD is often increased by 5-10%.

<Example>

TDD 60 units → Increased by 40-60% → 84-96 units → 36 units glargine + 18 units aspart TID-AC

90 units * 0.4 = 36 units basal
90 units * 0.6 = 54 units total prandial

Despite increasing the regimen to 36 units glargine, 18 units aspart on 11/4/2021, the following are the trends.

	Breakfast	**Lunch**	**Dinner**	**Nighttime**
11/5/2021	237	341	412	389
received:	36G+18A+2	18A+5	18A+7	18A+6
11/6/2021	390	364	340	310
received:	36G+18A+6	18A+6	18A+5	18A+4

You have increased the insulin regimen and are texting the endocrinology fellow to see if she approves of it.

Q. How would you calculate the new dose?

If the sliding scale regimen has successfully corrected your BG, it is reasonable to add the sliding scale regimen and distribute to basal-bolus.

The key is that the patient's BG is still not controlled. In this case you would need a further increase.

	Breakfast	**Lunch**	**Dinner**	**Nighttime**	
11/5/2021	237	341	412	389	=> total 110 units received
received:	36G+18A+2	18A+5	18A+7	6	
11/6/2021	390	364	340	310	=> total 111 units received
received:	36G+18A+6	18A+6	18A+5	4	

⇒ Since the patient is not controlled with around 110-111 units, you would increase this TDD by 10-20%.

⇒ 110 * 1.1 = approx. 120 units.

Basal = 120 * 0.4 = 48 units Glargine
Total bolus = 120 * 0.6 = 72 units Aspart => 48 units Glargine, 24 units Aspart TID-AC.

<Summary- **Inpatient Adjustment of Insulin>**

There are no ADA/AAFP published guidelines for insulin titrations; however,

- Most cases of hyperglycemia, without signs of DKA/HHS, are not emergency situations.
- Uncontrolled BG levels do increase the risk of hospital-acquired infections, higher mortality from MI, etc.
- For complicated cases such as steroid-induced hyperglycemia, Endocrinology consult should be obtained for the safest increase in insulin.

- Most cases of **hypo**glycemia (<70mg/dl), however, should be handled with urgent care and attention.
- Insulin doses should be appropriately decreased or held by the primary team.
- A low **fasting morning** glucose means that the basal insulin is excessive.
- A low **post-prandial** glucose means that the prandial insulin is excessive compared to their meals, and the patient's diet and insulin administration times should be assessed.

- Endocrinology should be consulted early for any concerns.

Case- Discharge

The patient is now stabilized on 45 units of glargine, 15 units of aspart, and a high-dose sliding scale. Unfortunately patient will have to be on long-term steroids due to her concern of cardiac sarcoidosis.

Patient will be discharged in 1-2 days. In anticipation, requests for refills for her insulin and insulin supplies.

Q. What kinds of questions would you ask the patient?

A) Ask whether she has an outpatient endocrinologist
B) Ask whether the patient uses a pen or syringe.
C) Ask whether the patient is comfortable using the equipment
D) Ask her to repeat the insulin regimen back to make sure she understands the regimen
E) All of the above

Insulin administration supplies:

Insulin pen

Pen needles

Insulin solution

Insulin syringe

Insulin pen

Pen needles

Usually 3ml each, comes in a box with 5 pens.

=> On the order menu, you would order 15ml.

Usually 1 box comes in with 90-100 needles.

=> Order 1 box or 100 needles.

Insulin solution

Usually 10ml each in each vial

=> On the order menu, you would order 10ml.
(or as multiples of 10mls)

Insulin syringe

Usually 100 syringes in a box

⇒ Order as 1 box or 100 syringes
⇒ For syringes, size matters depending on the amount of insulin.
(0.3mL syringes for <30 units,
0.5mL syringes for 30-50 units,
1.0mL syringes for >50 units)

Demonstration

Glucose monitoring supplies (there are 5):

Glucometer

Lancets

Strips

Lancet Devices

Alcohol swabs

The **UMMS Insulin Supply Orderset** already has all the presets!

Orders (for 1 month supply):

-Glucometer- All insurance companies have different formularies, process with outpatient pharmacy
-Lancets- **100 lancets**
-Lancet device- **1 device**
-Strips- **100 strips**
-Alcohol swabs- **1 box**

In the patient instructions/signature, you will have to write
"Test blood sugars 3-4 times daily, or 6-10 times if your sugars are frequently low."

Demonstration

<Summary- **Discharging with Insulin>**

- If you are unsure regarding the patient's discharge regimen, get **Endocrinology** involved 1-2 days before anticipated discharge
- If you are unsure regarding the patient's ability to **follow the regimen,** get **Diabetes Education** involved 1-2 days before anticipated discharge.

- Orders—
  - Pen + Pen needle or Solution + Syringe
  - Glucometer
  - Strips for the glucometer (**100 strips**)
  - Lancets (**100 lancets**), Lancet device (**1 device**)
  - Alcohol swabs (**100 swabs**)
- Order the supplies early to the pharmacy so they can see if they are covered by insurance!

Extra Case-

A Case of T1DM

29 y.o. F with hx of T1 DM (A1c 13.4, on glargine 25u + aspart 5u TID-AC), HTN, MI in 2016, recurrent admission for DKA, came to the ED for nausea and vomiting at 10 a.m.

Due to her lack of appetite patient did not take any insulin yesterday. The initial BMP were as follows:

135	99	14	356
4.1	22	0.9	

AG 14

Patient was admitted to Med/Surg for concern of gastroparesis, and was scheduled for a decreased dose of glargine at 15 units **nightly** + LDSSI.

12 hours later at 10pm, the MAO was called for a FS glucose of 524. At bedside patient was more fatigued but still alert and oriented. Vitals were BP 101/64, HR 97, afebrile. The repeat BMP showed the following:

137	99	26	499
4.5	**12**	1.0	

AG 26

Q. What happened? What is the differential?

A. Patient has not received any insulin for the past 36 hours (24 hours of no insulin + 12 additional hours because the glargine was scheduled for nighttime), and so there is a high suspicion for **DKA**.
Type 1 diabetes patients have an **absolute** insulin deficiency rather than a relative insulin deficiency, and should not be off of insulin for a prolonged period of time.

The differential includes starvation ketosis, but given the history suggestive of DKA and patient's fatigue, patient should be considered for ICU level of care to start insulin drip. However, in mild to moderate DKA such as this case, administration of rapid-acting analogs with aggressive fluid management could be just as effective. (Andrade-Castellanos CA, *Cohcrane Database Syst Rev* 2016)

Patient was started on insulin drip in the ICU. Beta-hydroxybutarate later returned as 1.92 (high).

Q. How could we prevent this?

A. Always ask type 1 diabetes patients when the patient last received their basal insulin. If it is more than 24 hours, patient should be started on a **long acting insulin immediately**.

   If the patient is currently having poor PO intake, **patient should still be on a low dose of long-acting insulin** as long as patient is not currently hypoglycemic. **Concurrent IV+PO glucose repletion may be needed.**

   If the patient is on an **insulin pump**, it is best to have Endocrinology involved. Oftentimes patients do not have the materials or the mental capacity (due to acute illness) to continue an insulin pump as inpatient, so often you may have to start a basal-bolus regimen.

Patient is currently stabilized on insulin drip at 1.1u per hour. Patient reports persistent nausea/vomiting and reports poor PO intake. The anion gap is 10.

Q. Should we transition this patient to basal-bolus insulin?

A. It is preferrable to bridge the patient to subcutaneous insulin when the patient has a good mental status and having good PO intake of fluids and food, in order to decrease hypoglycemia risk. (Kitabchi et al, *Diabetes Care*, 2009)

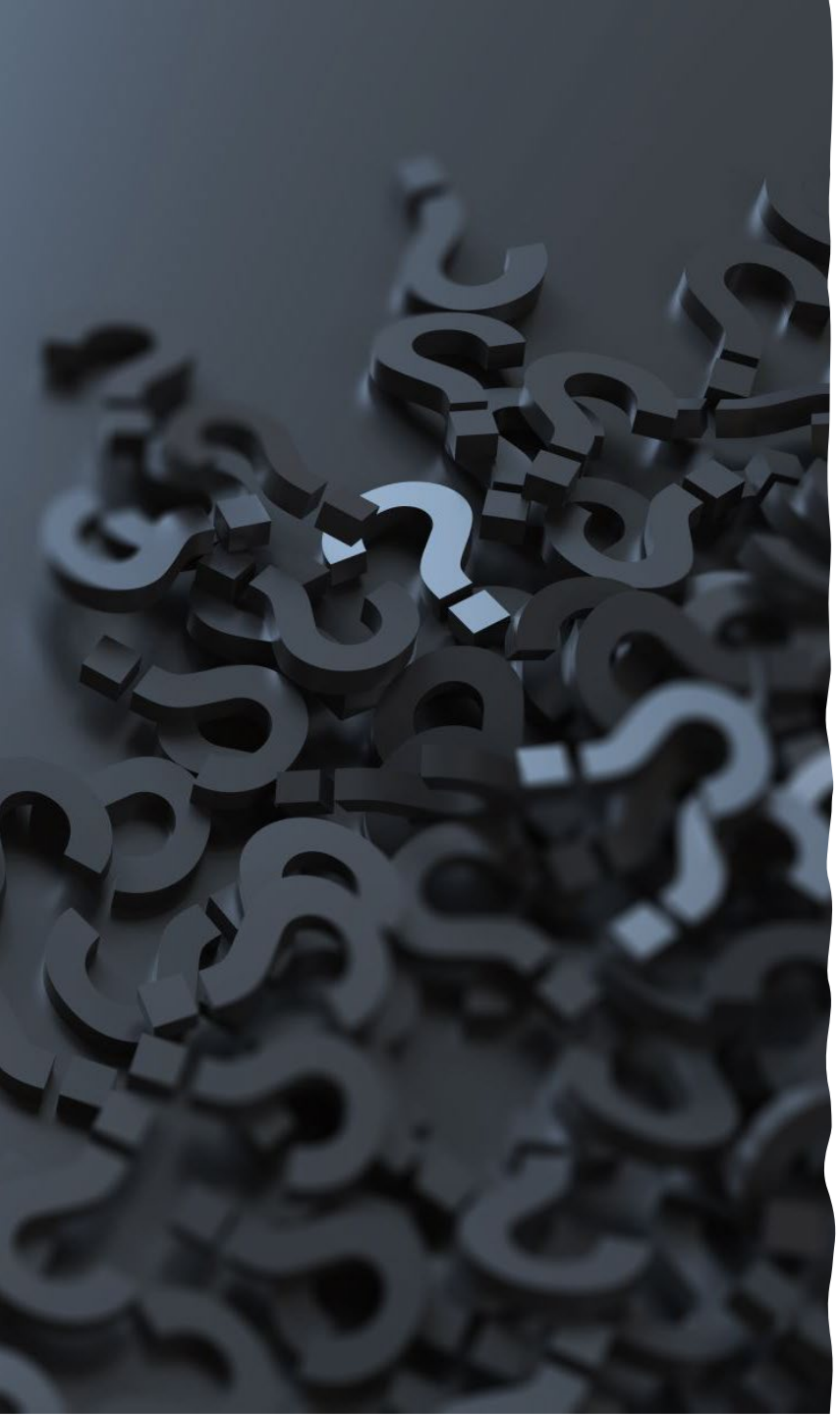
Q. How would we dose her subcutaneous insulin once she is able to take PO?

A. Dosing based on the patient's insulin drip, or patient's weight, or based on her previous outpatient regimen are both viable options.

Patient was later started on glargine 20 units + aspart 5 units with meals with good glucose control.

<Summary- **T1DM admissions**>

- Type 1 diabetes patients should always be on a basal insulin or a continuous pump.
- At admission, the patient's outpatient regimen should be verified and the last time the patient took insulin should be verified.
- Just as in T2DM, if the patient is stable, admission insulin doses should be based on the patient's outpatient regimen.
- If the patient is on an insulin pump, consult Endocrinology to calculate the appropriate basal-bolus regimen.



Thank you