

CASE: 52 yo woman with type II diabetes is admitted with pyelonephritis. At home she takes glargine 28 units subcutaneous at bedtime and lispro 8 units subcutaneous before each meal and metformin 1000 mg twice daily. Her blood sugars usually range in the 200s; she has had no hypoglycemic episodes. Her last HgbA1c was 8.9%. On admission the patient is febrile with T 38.9 °C; her wbc is 19K and her glucose is 309. The patient is admitted and started on antibiotics.

What is your goal for the patient's glycemic control in the hospital? What is the importance of controlling her blood sugars during admission? What insulin regimen would you write as part of her admission orders? What other medication changes might you make?

Inpatient Glycemic Control

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Risks of hyperglycemia Associated with impaired immune function and wound healing, increased risk of surgical site infection, increased risk of developing acute renal failure necessitating hemodialysis, worsened ischemia (MI, CVA), increased likelihood of ICU admission, duration of mechanical ventilation, length of stay and overall and disease-specific mortality. There is a risk of DKA particularly in patients with type I DM. Hypoglycemia increases mortality three-fold compared with hyperglycemia but is much less common.

Goals

- ▶ General Medicine Ward: post-meal glucose <= 180
- ▶ Avoid hypoglycemia

Management principles

Attempt to mimic physiologic insulin release

Types of exogenous Insulin

		Onset (hours)	Peak (hours)	Duration (hours)
BASAL →	NPH	1-2	6-12	18-24
	Glargine	2	none	24
PRANDIAL →	Regular	1/2	2-4	6-8
	Lispro (Aspart)	1/4	1	3-4

Use outpatient regimen to guide your inpatient decisions

- Assess control with outpatient regimen
 - If a patient's blood sugars are well controlled as an outpatient, it is reasonable to use the outpatient regimen as a starting point for insulin dosing; however if a patient has frequent hypoglycemia, consider lower initial insulin doses
- Remember that diet may be different in the hospital; patients may also do less physical activity
- Sick patients may eat less than normal but may still require higher insulin doses

Insulin Strategy

schedule **BASAL** + schedule **PRANDIAL** + add **SUPPLEMENTAL**

BASAL: covers basic metabolic requirements generally independent of intake (consider also obesity, infection, steroids)

Required for patients with type I DM (usually can continue Glargine and NPH at usual dose)
If a patient with type II DM is eating but is eating less than usual, consider small reduction in glargine dose particularly if outpatient dose is >60 Units, reduce dose if patient has prandial output coverage consider lowering dose by 10 - 20% and consider decreasing NPH by 1/3

PRANDIAL: covers potential glucose increase after each meal

For patients who are eating, prescribe *usual* prandial insulin; if not eating much, decrease dose; if not eating at all – discontinue scheduled prandial insulin

SUPPLEMENTAL OR “CORRECTION” DOSE: add to prandial to treat pre-meal hyperglycemia; accounts for inadequate prior dosing particularly in the setting of acute illness, steroid administration, and under-dosing

Lispro/aspart are better choices for supplemental doses given shorter onset/duration of action

Avoid traditional “sliding scale insulin” (SSI) that determines an amount of short-acting insulin to be given based on a chemstick checked every 6 hours regardless of oral intake or meals. SSIs are reactive and do not anticipate insulin

Re-evaluate regimen EVERY day!

- Adjust basal insulin based on pre-breakfast blood sugar
- Adjust prandial insulin based on pre-lunch, pre-dinner and pre-bedtime blood sugar
- Usually can adjust by 15-25% if clinical scenario is otherwise stable
- Do not treat an elevated pre-bedtime glucose unless clinically indicated (for example, chemstick is >400 and patient is acidemic); adjustments in response to pre-bedtime chemstick values should generally be made the following day. If short-acting supplemental dose insulin is given in response to a pre-bedtime glucose, check chemstick at 2 AM to ensure that patient is not hypoglycemic (If high at 2AM re-check – do NOT treat (unless patient is sicker or acidotic)
- If patient is hypoglycemic at bedtime, consider bedtime snack.

Case follow-up: On admission the patient was eating although less than normal. She was started on glargine 28 units with lispro 4 units prior to meals with additional supplemental insulin – low dose correction. Her metformin was held. Over the first 24 hours of admission her chemsticks were as follows:

Pre-breakfast	Pre-lunch	Pre-dinner	Bedtime
227	280	210	305

Her basal insulin/glargine was increased to 32 units and her prandial insulin was changed to 9 units with supplemental insulin.

The following day her chemsticks were as follows:

Pre-breakfast	Pre-lunch	Pre-dinner	Bedtime
174	195	160	202

On HD#3 the patient continued to have fevers and her wbc increased to 24K. Abdominal CT with IV contrast demonstrated a right perinephric abscess and the patient was made npo after midnight for planned percutaneous drainage. How should her diabetes regimen be adjusted?

Glycemic Control in the Inpatient who is NPO

Patients with DM – especially type I – NEED insulin even if they are NPO

Insulin drips

Helpful for glycemic control in the patient who is npo if institution has experience with drips. Can also be used in patients to help determine regimen if starting patient on continuous tube feeds or TPN. Variable rate IV infusion; adjusted by protocol combined with dextrose-containing maintenance fluids. Chemsticks are checked every hour until stable.

Pitfalls: **Hypoglycemia can occur if:**

- turning off dextrose-maintaining fluids/tube feeds while insulin running
- no changes made to insulin rate when blood glucose falls rapidly
- no insulin administered prior to stopping drip
- **Hyperglycemia & DKA can occur if:**
- renal insufficiency may lead to insulin 'stacking', insulin is not cleaned normally potentially leading to hypoglycemia

Transitioning drip to subcutaneous insulin:

- Transition patient when s/he is able to eat (or on stable feeds)
- Discontinue drip at the time that you would usually give basal insulin
- Give NPH ~4 hours PRIOR to stopping drip; give glargine the night before stopping drip
- Can give ½ usual glargine dose as NPH in the AM 4 hours before stopping the drip

If patient is on stable rate of continuous tube feeds (and tolerating them), consider giving approximately 60% of 24 hour insulin requirement divided q12 hours as NPH insulin with supplemental regular insulin subcutaneous every six hours as needed. This allows for variations in tube feed delivery such as high residuals, tube malfunction, pulled tube, etc. to prevent prolonged hypoglycemia.

If insulin drip is not an option:

Basal insulin: 100% NPH night before; 50% of AM NPH
50-100% glargine the night before (if type I DM – may be able to use 100%)
Supplemental: Lispro/aspart preferable to regular insulin; avoid doses < 4 hours apart

Oral Diabetes medications

Metformin: discontinue prior to surgery or IV contrast examinations or on admission
hold 48 hours post surgery or contrast if creatinine normal (if creatinine is abnormal (creatinine >1.5 in men and 1.4 in women), do not resume metformin until creatinine normalized
lactic acidosis is rare – however, it remains a black box warning
stop in patients admitted with worse renal or hepatic function or heart failure

Sulfonylureas: hold if patient has acute renal failure particularly in the elderly or if the patient is npo; renal failure (decreased clearance) or npo status may result in significant and sustained hypoglycemia, hold the morning of procedure.

Case follow-up: After the patient was made NPO, she was started on an insulin drip at 1.5 units per hour together with D5 ½ NS at 100 cc/hour. She underwent percutaneous drainage in Interventional Radiology. On the morning after her procedure, she was hungry and ready to eat; she was given 15 units of NPH and the drip was weaned off over the next 4 hours. She received 8 units of lispro subcutaneous pre-lunch and pre-dinner and glargine 32 units subcutaneous was given that evening. The next day she was discharged to home on glargine 30 qhs and lispro 8 units QAC and to follow up closely with her primary care provider. Her creatinine remained normal throughout her stay and her metformin was resumed at discharge.

Pearls:

- Glycemic control is imperative in the hospital

- All patients with type I DM must have insulin
- Re-evaluate glycemic control regimens EVERY day
- Avoid traditional sliding scale regimens
- Insulin drips are excellent tools for controlling blood sugars in the patient who is NPO
- Subcutaneous insulin must be administered prior to discontinuing an insulin drip

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