

INPATIENT DIABETES MANAGEMENT

Robert J. Rushakoff, MD, Professor of Medicine, Director, Inpatient Diabetes, University of California, San Francisco

Updated May 30, 2022

CLINICAL RECOGNITION

Background

Appropriate inpatient glycemic management limits the risks of severe hypo- and hyperglycemia. Preventing and treating hyperglycemia reduces infections and minimizes fluid and electrolyte abnormalities. Specific glucose goals remain fluid. Hyperglycemia and hypoglycemia are associated with poor outcomes but the few prospective randomized studies have failed to demonstrate consistent improvements. For example, intensive glycemic control in the ICU increased mortality in one large trial. At this point, glucose goals should be thoughtful and tailored to the institution and its resources. To successfully manage inpatient diabetes, institutional infrastructure must be in place with institution specific guidelines and protocols for which all nursing staff, pharmacy staff, physicians, and others must be educated. The general guidelines below are appropriate at most institutions.

Check A1c level in all patients with diabetes and individuals with glucose levels greater than 140mg/dL if not performed in the prior 3 months to evaluate prior glycemic control.

Insulin therapy should be initiated if glucose levels are persistently ≥ 180 mg/dL. Once insulin therapy is started, a target glucose range of 140–180 mg/dL is recommended for most hospitalized patients but in selected patients (e.g., critically ill postsurgical patients or patients with cardiac surgery) glucose levels between 110–140 mg/dL may be targeted if they can be achieved without significant hypoglycemia. Glucose levels between 180–250 mg/dL may be acceptable in patients with severe comorbidities and in hospitals where frequent glucose monitoring or close nursing supervision is not possible. In terminally ill patients with a short life expectancy glucose level >250 mg/dL with less aggressive insulin regimens to minimize glucosuria, dehydration, and electrolyte disturbances may be appropriate.

Physiologic Insulin Regimen

All patients have “basal, nutritional, and correctional” requirements which they must meet with endogenous or exogenous insulin.

- **Basal:** insulin needed even when patient is not eating (to control gluconeogenesis). Use long-acting insulins such as glargine (usually once daily in AM or at bedtime) or detemir (once daily or q 12 hours). If there are financial limitations NPH at

bedtime or AM and bedtime may be used. Additionally, a continuous insulin infusion can provide basal insulin and is often employed in ICU settings.

- **Nutritional:** insulin to cover carbohydrate intake from food, dextrose in IV fluid, tube feeds, TPN. Use rapid-acting insulin (aspart, lispro, or glulisine) or if financial limitations short-acting insulin (regular).

- **Correctional:** insulin given to bring a high blood glucose level down to target range (with target usually below 150 mg/dL pre-meal, and below 200mg/dL at bedtime or 2am). Use rapid-acting insulin (aspart, lispro, or glulisine) or short-acting insulin (regular).

General Rules

- A PATIENT WITH TYPE 1 DM WILL ALWAYS NEED EXOGENOUS BASAL INSULIN, EVEN IF NPO. FAILURE TO GIVE SUCH A PATIENT INSULIN WILL LEAD TO DKA.

- Arbitrary sliding scale insulin should be avoided as it is not only ineffective but also potentially dangerous.

- Ad hoc insulin orders should not be used. Comprehensive electronic medical record (EMR) order sets, or pre-printed order forms should only be used to order subcutaneous insulin and insulin infusions. This standardization will decrease the risks of insulin dosing and administration errors.

- Check blood glucose (BG) before meals and at bedtime. Check BG q 4 or q 6 hours in a patient who is NPO or is receiving continuous tube feeds or TPN. Continuous glucose monitoring may be used in certain patients (for example it was used in patients with COVID-19 infections to minimize patient contact).

- Involve the diabetes educator or nurse specialist if available.

- On admission, begin planning discharge, especially if the discharge plan will require new

outpatient insulin use. Identify whether the patient will need a new glucose meter. Prescribe insulin, insulin pens with pen needles, syringes/needles, lancets, glucose strips, glucose tablets, and glucagon kit in the discharge prescription if needed.

Oral Hypoglycemic Agents

In general, oral diabetes medications and injectables other than insulin (e.g., GLP agonists) are inappropriate for initial management of the hyperglycemia patient. Hospitalized patients often have the potential for renal impairment, tissue hypoxia, or need IV contrast, and these are all contraindications for using metformin. Sulfonylureas should be held on admission because of current or potential NPO status resulting in a high risk of hypoglycemia. As a patient's status improves, however, it may be appropriate to restart oral medications. DPP4 inhibitors may be useful for patients who have minimally elevated glucoses as there is a minimal risk for hypoglycemia.

Miscellaneous Guidelines

- Nutritional coverage: Regular insulin is given 30 min before each meal. Lispro, aspart, or glulisine are given with each meal or immediately after eating (can base on amount eaten).

- Infection and glucocorticoids increase insulin needs; renal insufficiency decreases insulin needs.

- Total daily dose of insulin needed: Type 1 patients require approximately 0.4 units/kg/day; type 2 patients vary in their insulin resistance and may require from 0.5 to 2 units/kg/day.

THERAPY

Insulin Regimens

The guidelines below assist with initial determination and subsequent adjustment of insulin doses. Insulin doses must be reevaluated on a daily basis and orders should be rewritten in order to achieve goals and to adapt to the patients' changing clinical situation.

INSULIN REGIMEN FOR A PATIENT CONTROLLED WITH DIET AT HOME BUT NEEDING INSULIN IN HOSPITAL

Day 1: Order a correctional sliding scale for before meals and bedtime (with lispro, aspart, glulisine or regular) based on BMI – see Table 1.

Day 2: If BG pre-meals are >150 mg/dL, add nutritional insulin (with lispro, aspart, glulisine or regular) based on appetite). Also, if AM fasting BG is >150 mg/dL, add bedtime basal insulin (with glargine, detemir, or NPH) dosed 0.1-0.2 unit/kg.

Day 3: Adjust insulin doses based on BG pattern: Increase or decrease basal insulin based on AM fasting BG, and adjust nutritional insulin based on pre-meal BG levels (see below for details).

Table 1. Correctional Insulin (lispro, aspart, glulisine or regular)				
BG (mg/dL)	Pre-meal: Sensitive (BMI <25 or <50 units/d)	Pre-meal: Average (BMI 25-30 or 50-90 units/d)	Pre-meal: Resistant (BMI >30 or >90 units/d)	Bedtime and 2 a.m.
131-150	0 units	1 unit	2 units	0 units
151-200	1 unit	2 units	3 units	0 units
201-250	2 units	4 units	6 units	1 unit
251-300	3 units	6 units	9 units	2 units
301-350	4 units	8 units	12 units	3 units
351-400	5 units	10 units	15 units	3 units
>400	6 units	12 units	18 units	3 units

INSULIN REGIMEN FOR A PATIENT ON ORAL AGENT(S) BUT REQUIRING INSULIN IN HOSPITAL BECAUSE OF HYPERGLYCEMIA OR CONTRAINDICATIONS TO THE ORAL AGENT(S)

Day 1: Start nutritional insulin (lispro, aspart, glulisine or regular) based on appetite – generally about 0.1-0.2 units per kg, divided between the three meals for the day. Also, order a correctional sliding scale (lispro, aspart, glulisine or regular) based on BMI – see Table 1.

Day 2: If AM fasting BG is >150 mg/dL, add bedtime basal (glargine, detemir or NPH) dose of 0.1-0.2 units/kg.

Day 3: Adjust insulin doses based on BG pattern: Increase or decrease basal insulin based on AM fasting BG, and adjust nutritional insulin based on pre-meal BG levels (see below for details).

INSULIN REGIMEN FOR A PATIENT ON INSULIN AT HOME

- If possible, consider home BG control, appetite, renal function, and risk for hypoglycemia.
- All three components of insulin replacement must be addressed: basal, nutritional and correctional.
- Basal requirements: Continue home regimen if patient has been well-controlled at home, but consider decreasing the total dose by 20-30% to reduce the risk of in-hospital hypoglycemia. Alternatively, start bedtime glargine, detemir or NPH at a dose of 0.2 units/kg
- Nutritional requirements: Order nutritional insulin (lispro, aspart, glulisine or regular) based on appetite, or consider pre-meal dosing of 0.2 units/kg divided by 3 for the dose at each meal.
- Correctional need: Order a correctional sliding scale based on total insulin dose or BMI – see Table 1.

INSULIN REGIMEN WHEN A PATIENT IS MADE NPO FOR A PROCEDURE

A patient will always require his or her basal insulin, even while NPO, and should not become hypoglycemic if that basal insulin is dosed appropriately. For safety purposes, however:

- The night before, give the usual dose of bedtime NPH, if applicable, or decrease the usual dose of bedtime glargine/detemir by 25%.
- The morning of, if applicable, decrease the usual dose of morning NPH by 50%, or decrease the usual dose of morning glargine by 25%.
- Do not give nutritional insulin (as patient is not eating), but continue the usual correctional insulin.
- (*An online resource to determine patient specific instructions when preparing for an NPO episode is at <http://ucsf.logicnets.com>*)

INSULIN REGIMEN FOR AN ICU OR SURGICAL PATIENT WHO IS NPO

Consider insulin infusion therapy.

INSULIN REGIMEN FOR A PATIENT STARTING CONTINUOUS TUBE FEEDING

- Consider insulin infusion therapy.
- If moving from IV to SQ see below.
- Basal need: The daily basal dose (glargine, detemir or total bid NPH dose) is the estimated total daily dose divided by 2.
- Nutritional need: Divide the estimated total daily dose by 10 for the total nutritional (lispro, aspart, glulisine or regular) dose, to be given q 4 hours while tube feeding is active.
- Correctional need: Order a correctional scale (lispro, aspart, glulisine or regular) based on total insulin dose or BMI (Table 1)
- If not using IV insulin to start:
- Estimate the tube feed formula's 24-hour carbohydrate load.
- Estimate the total daily dose (TDD) of insulin, starting with 1 unit insulin for every 10 grams carbohydrate.

INSULIN REGIMEN FOR A PATIENT RECEIVING TPN

- Standard TPN often contains 25% glucose, which, if 100 ml/hour, yields 25 g glucose/hour.
- Basal and nutritional needs: Adding insulin to the TPN is safest, as the unexpected discontinuation of TPN will also mean the discontinuation of the insulin. Start with 0.1 unit per gram glucose. If patient previously needed high doses of basal insulin, divide that total daily dose by the number of TPN

bottles to be administered daily, and add that to the prior calculation.

- Correctional: Order a correctional sliding scale (lispro, aspart, glulisine or regular) based on BMI (Table 1).

INSULIN REGIMEN TO TRANSITION FROM AN INSULIN INFUSION TO SUBCUTANEOUS INSULIN

- Calculate the patient's total daily dose (TDD) of insulin, based on the most recent insulin infusion rate. For safety purposes, take 80% of that dose.

- Basal need: Divide the 80% of the TDD by 2 and give half for the daily glargine, detemir, or total NPH dose.

- Nutritional need: If the patient is eating, divide the 80% of the TDD by 6 for the pre-meal lispro, aspart, glulisine, or regular dose. If the patient is receiving tube feeds, divide the 80% of the TDD by 10 for the nutritional (lispro, aspart, glulisine or regular) dose, to be given q 4 hours. If the patient is not receiving nutrition, do not order nutritional insulin.

- Correctional need: Order a q4h correctional scale (lispro, aspart, glulisine, or regular) based on total insulin dose or BMI (Table 1).

- Give the first basal insulin SQ injection 1-2 hours before the infusion is discontinued. If the transition is being made in the morning, consider using a one-time AM NPH injection or ½ of daily glargine or detemir dose to bridge until bedtime glargine, detemir or NPH begins.

INSULIN REGIMEN FOR A PATIENT RECEIVING GLUCOCORTICIDS

- Glucocorticoids may dramatically increase postprandial BG levels but have little effect on gluconeogenesis (fasting glucose levels). Often, BG levels are very high during the day, then lower overnight.

- Anticipate post-prandial hyperglycemia by increasing the nutritional insulin doses.

- The insulin dose will typically increase by 50% from before glucocorticoid use and the total amount may be 0.5 to significantly >1 Unit/kg

DAILY INSULIN ADJUSTMENTS

There are no validated formulas for making these adjustments, but the following rules generally work well.

- Basal Insulin: Generally, the basal insulin dose is adjusted based on fasting glucose levels. For example, if FBS <140, no change. If FBS 141-160, increase basal dose by 2-3 units. If FBS 160-180, increase basal dose by 4-5 units. If FBS 180-200, increase basal dose by 6-7 units. If FBS >200, increase basal dose by 8 units. With this approach, the basal insulin can be titrated up to the patient's actual requirement relatively quickly.

- Nutritional Insulin: The adequacy of the nutritional insulin dose is based on the glucose level prior to the next meal. For example, the glucose level just before lunch will indicate whether the insulin given at breakfast was appropriate. The glucose level at bedtime will indicate whether the insulin given at dinner was appropriate. A simple approach is as follows: If there was no significant change in the glucose level from before breakfast to before lunch, then the total dose of insulin the patient received at breakfast (nutritional plus correctional) should be used as the nutritional dose for breakfast the next day. If there was a significant increase in the glucose level from before breakfast to before lunch, then the total dose of insulin the patient

received at breakfast (nutritional plus correctional) should be increased and should become the nutritional dose for breakfast the next day. If the glucose level before breakfast was high, and the glucose level at lunch was at goal, then no change in the nutritional dose will be required for the next day. Finally, no matter what the glucose level was at breakfast, if the glucose level after breakfast or before lunch was low, then the breakfast nutritional dose should be decreased for the next day.

Hypoglycemic Protocols

- BG <70 mg/dL: If patient taking po, give 20 grams of oral fast-acting carbohydrate either as glucose tablets or 6 oz. fruit juice. If patient cannot take po, give 25 mL D50 IV push.
- Check BG every 15 minutes and repeat above treatment until BG is \geq 100 mg/dL.

Insulin Infusions

- Use your hospital's pre-printed order form or protocol in EMR and hospital-specific protocol for insulin infusions. Using an insulin infusion without a

REFERENCES

1. Society for Hospital Medicine Diabetes Resource Room: <http://www.hospitalmedicine.org/ResourceRoomRedesign/GlycemicControl.cfm>
2. Dhatariya K, Corsino L, Umpierrez GE. Management of Diabetes and Hyperglycemia in Hospitalized Patients. 2020

standardized protocol and trained providers can be unsafe.

- Continuous glucose intake (in IV fluid or continuous TPN or tube feeds) is required during the infusion. Remember to manually adjust the infusion rate and/or the algorithm if there are changes in nutrition (e.g., if tube feeding or TPN is held) or other rapid changes in medical status.

- When converting to SQ insulin, give the basal SQ dose 1-2 hours before discontinuing the insulin infusion.

GUIDELINE

Diabetes Care in the Hospital: Standards of Medical Care in Diabetes—2022

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PMID: 25905318