INPATIENT DIABETES MANAGEMENT
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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. Actual goals remain fluid. For example, intensive glycemic control in the ICU increased mortality in one large trial, and thus blood 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 have to be educated. The general guidelines below are appropriate at most institutions.

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 glargine (usually once daily in AM or at bedtime), NPH (at bedtime, or AM and bedtime), detemir (once daily or q 12 hours), or a continuous insulin infusion.
- **Nutritional**: insulin to cover carbohydrate intake from food, dextrose in IVF, tube feeds, TPN
  
  Use rapid-acting insulin (aspart, lispro, or glulisine) or 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.
- If available, use pre-printed order forms or online protocol specific order entry for subcutaneous insulin and insulin infusions. This will decrease the risk 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.
- 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, syringes/needles, lancets, glucose strips, glucose tablets, and glucagon kit in the discharge prescription if needed.

Oral hypoglycemic agent:
- Oral medications: In general, oral diabetes medications and injectables other than insulin (eg 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.

Miscellaneous guidelines:
- **Nutritional coverage**: Regular insulin is given 30 min before each meal. Lisptro, aspart, or apidra 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

Infection 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.

1. Insulin regimen for a patient controlled only with diet at home, but needing insulin in hospital:
   • Day 1: Order a correctional sliding scale for before meals and bedtime (with lispro, aspart, apidra or regular) based on BMI – see Table 1.
   • Day 2: If BG pre-meals are >150 mg/dL, add nutritional insulin (with aspart 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 (aspart or regular)

<table>
<thead>
<tr>
<th>BG (mg/dL)</th>
<th>Pre-meal: Sensitive (BMI &lt;25 or &lt;50 units/d)</th>
<th>Pre-meal: Average (BMI 25-30 or 50-90 units/d)</th>
<th>Pre-meal: Resistant (BMI &gt;30 or &gt;90 units/d)</th>
<th>Bedtime and 2 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>131-150</td>
<td>0 units</td>
<td>1 unit</td>
<td>2 units</td>
<td>0 units</td>
</tr>
<tr>
<td>151-200</td>
<td>1 unit</td>
<td>2 units</td>
<td>3 units</td>
<td>0 units</td>
</tr>
<tr>
<td>201-250</td>
<td>2 units</td>
<td>4 units</td>
<td>6 units</td>
<td>1 unit</td>
</tr>
<tr>
<td>251-300</td>
<td>3 units</td>
<td>6 units</td>
<td>9 units</td>
<td>2 units</td>
</tr>
<tr>
<td>301-350</td>
<td>4 units</td>
<td>8 units</td>
<td>12 units</td>
<td>3 units</td>
</tr>
<tr>
<td>351-400</td>
<td>5 units</td>
<td>10 units</td>
<td>15 units</td>
<td>3 units</td>
</tr>
<tr>
<td>&gt;400</td>
<td>6 units</td>
<td>12 units</td>
<td>18 units</td>
<td>3 units</td>
</tr>
</tbody>
</table>

2. Insulin regimen for a patient on oral agent(s) at home but requiring insulin in hospital because of hyperglycemia or contraindications to the oral agent(s):
   • Day 1: Start nutritional insulin (aspart 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 (aspart or regular) based on BMI – see Table 1.
   • Day 2: If AM fasting BG is >150 mg/dL, add bedtime basal (glargine, levemir 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).

3. 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. Or, start bedtime glargine, detemir or NPH dose of 0.2 units/kg.
• Nutritional requirements: Order nutritional insulin (lispro, aspart, apidra 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.

4. **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 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%.
• Don’t give nutritional insulin (as patient 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)

5. **Insulin regimen for an ICU or surgical patient who is NPO:** Consider insulin infusion therapy.

6. **Insulin regimen for a patient starting continuous tube feeds:**
• Consider insulin infusion therapy.
• 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.
• Basal need: The daily basal dose (glargine, detemir or total bid NPH dose) is the estimated TDD divided by 2.
• Nutritional need: Divide the estimated TDD by 10 for the total nutritional (lispro, aspart, apidra or regular) dose, to be given q 4 hours while tube feeding is active.
• Correctional need: Order a correctional scale (aspart or regular) based on total insulin dose or BMI – see Table 1.

7. **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 (aspart or regular) based on BMI – see Table 1.

8. **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 nightly 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 aspart or regular dose. If the patient is receiving tube feeds, divide the 80% of the TDD by 10 for the nutritional (lispro, aspart, Apidra 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, apidra or regular) based on total insulin dose or BMI – see 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, detemir or NPH begins.

9. **Insulin regimen for a patient receiving glucocorticoids:**
• Glucocorticoids may dramatically increase postprandial BG levels but have little effect on
 gluconeogenesis. Often, BG levels are very high during the day, then lower overnight.
• Anticipate post-prandial hyperglycemia by increasing the nutritional insulin doses.

10 Daily insulin Adjustments:
These 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.

For this example, the patient has 5 units aspart ordered for breakfast. He or she is on a sensitive
correction dose (see Table 1 above).

<table>
<thead>
<tr>
<th>Prebreakfast glucose</th>
<th>Insulin given for breakfast (nutritional + correctional)</th>
<th>Prelunch glucose</th>
<th>Intervention for next day</th>
<th>Nutritional prebreakfast dose next day</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>210</td>
<td>If there is no significant change in the glucose level from before breakfast to before lunch, then the dose of insulin the patient received at breakfast (nutritional plus correction) would be an appropriate nutritional dose for breakfast the next day</td>
<td>7 units</td>
</tr>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>260</td>
<td>If there is a significant increase in the glucose level from before breakfast to before lunch, then the dose of insulin the patient received at breakfast (nutritional plus correction) would need to be increased and become the nutritional dose for breakfast the next day</td>
<td>8 units</td>
</tr>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>138</td>
<td>If the glucose level before breakfast had been high, and the glucose level at lunch is at goal, then no change in the nutritional dose will be required for the next day</td>
<td>5 units</td>
</tr>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>60</td>
<td>No matter what the glucose level was at breakfast, if the glucose level after breakfast or before lunch is low, then the breakfast nutritional dose needs to be decreased for the next day</td>
<td>3 units</td>
</tr>
</tbody>
</table>

**Hypoglycemia protocol:**
- BG <70 mg/dL: If patient taking po, give 20 gms 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 ≥100 mg/dL.

**INSULIN INFUSIONS**
- Use your hospital’s pre-printed order form and hospital-specific protocol for insulin infusions. Using an insulin infusion without a standardized protocol and trained providers can be unsafe.
- Continuous glucose intake (in IVF, 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.

For online training on inpatient DM management:

For program to determine preoperative medication/insulin dosing for any diabetes patient: ucsf.logicnets.com

### Insulins Available in the US

<table>
<thead>
<tr>
<th>Types and Preparations</th>
<th>Action profile (h)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Onset</td>
</tr>
<tr>
<td>Rapid-acting</td>
<td></td>
</tr>
<tr>
<td>Lispro/aspart/glulisine</td>
<td>0.25</td>
</tr>
<tr>
<td>Regular</td>
<td>0.5</td>
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<tr>
<td>Intermediate-acting</td>
<td></td>
</tr>
<tr>
<td>NPH</td>
<td>1-2</td>
</tr>
<tr>
<td>U-500</td>
<td>1-3</td>
</tr>
<tr>
<td>Long-acting</td>
<td></td>
</tr>
<tr>
<td>Glargine</td>
<td>1.5</td>
</tr>
<tr>
<td>Detemir</td>
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</table>

### Insulin: Use and Adjustments

<table>
<thead>
<tr>
<th>Types and Preparations</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injection</td>
</tr>
<tr>
<td>Rapid-acting</td>
<td></td>
</tr>
<tr>
<td>Lispro/aspart/glulisine</td>
<td>10 min premeal</td>
</tr>
<tr>
<td>Regular</td>
<td>30 min premeal</td>
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<tr>
<td>Intermediate-acting</td>
<td></td>
</tr>
<tr>
<td>NPH</td>
<td>Morning</td>
</tr>
<tr>
<td></td>
<td>Night</td>
</tr>
<tr>
<td>Long-acting</td>
<td></td>
</tr>
<tr>
<td>Glargine/detemir</td>
<td>PM</td>
</tr>
</tbody>
</table>
A few Key Basic Insulin Concepts

**Transition from IV to SQ Insulin**

- Take 80% of last 24 h insulin infusion
  - Basal: ½ of the value
  - Premeal: ½ of the value divided for the meals
- Example: 1.5 units per hour = 36U
  - 36 x .8= 29
  - Basal: 30x.5=15
  - Premesal: 30x.5 = 5 per meal

**Patient on Insulin who is Eating**

- In general - continue patient's normal outpatient insulin regimen
- Do not stop the outpatient insulin and use a sliding scale
- If outpatient glucose have been poorly controlled on current insulin regimen, consider starting more appropriate insulin regimen
- If in good control, - cut back to 70%

In general - to prevent hypoglycemia, for most type 2 patients on insulin, cut back the insulin to 70-80% of outpatient dose. If very high dose of glargine, may consider 50%

**Patient on Insulin who is Eating**

- Easy method:
  - Choose the U/kg (.3 to .5 U/kg)
  - Basal: ½ of the value
  - Premesal: ½ of the value divided for the meals
  - Glucocorticoids: 0.5 U/kg (1/4 basal, 3/4 premeal), generally if on insulin, need 30-50% increase

- If on premixed insulin changing to MDI:
  - Basal: ½ of the total dose
  - Premesal: ½ of the total dose divided for the meals

**Tube Feeds**

**Method 1:**
- Take the last 24 hour insulin infusion
  - Basal: 24 hour total/2
  - Aspart: 24 hour total/10 given q4h

**Method 2:**
- Similar to Method 1 – just using a higher proportion of basal insulin

**Method 3:**
- If no IV – just use 1 unit per 6-10g CHO to start and calculate as per #1