Diabetes Treatment for Medically Complicated Patients

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Presentation Primary Objective

To understand the use of subcutaneous insulin to effectively achieve the desired glycemic outcomes in non-critically ill hospitalized patients
1. Understand the parameters of appropriate glycemic control in hospitalized patients
2. Recognize the obstacles to appropriate glycemic control in hospital patients
3. Differentiate basal bolus, prandial, and correctional insulin
4. Review special cases including newly diagnosed diabetics, steroids, tube feedings, infections, and planning for discharge

### Diabetes Categories

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* Diabetes Care, vol. 33, Suppl. 1, January, 2010
1. Above 180 two times is considered ‘uncontrolled DM’ and a change needs to be made in insulin management
2. Use of correction scale is sign of a treatment failure
3. Uncontrolled DM patients should be on all 3 insulin categories: basal, prandial, and correctional
   Remember 50/50 rule:
   • 50% of total daily insulin requirement should be basal
   • 50% should be nutritional

4. Identify trends in CBGs throughout day
5. Avoid clinical inertia by intensifying insulin treatment:
   * Consistently high fasting CBGs
   * Upward trend throughout day
   * If patient on tube feedings, consistent CBGs throughout 24 hour period
6. Check MAR and administration times before making changes
Managing Diabetes in the Hospital Presents Different Challenges than Managing Diabetes in the Outpatient Arena!

The hospital is associated with:
- Nutritional and clinical instability
- The need for changes from the home diabetes medical regimen
- Acute illness, “stress-related” hyperglycemia
- Use of medications that impact glycemic control

Issues Related to Glycemic Control

*Choice of initial regimen in the hospital.
*Poor glycemic control ignored/accepted.
*Reliance on sliding scale insulin.
*Inappropriate follow up of hypoglycemia.
*“Stacking” of insulin dosing.
*Communication between services.
*Inconsistent approach to insulin ordering
*Nurse to physician communication.
*Poor coordination of tray delivery, monitoring, and insulin
Hyperglycemia occurs frequently in hospital patients, and is associated with poor outcomes.

Hypoglycemia occurs frequently in hospital patients, and is unpleasant and dangerous.

Adequate metabolic control is an attainable goal for hospital patients.

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**Goal Range of CBGs**

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<th>Hypoglycemia</th>
<th>Somewhere in the Middle</th>
<th>Hyperglycemia</th>
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<td>&lt;40</td>
<td>70</td>
<td>140</td>
</tr>
<tr>
<td>110</td>
<td>170</td>
<td>&gt;200</td>
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*All CBGs to be between 80-180

*2 readings >180 is a failed day and a change should be made to scheduled insulin

*2 readings < 100 should alert the provider that the hospitalized patient is at risk for hypoglycemia; reduce the total daily insulin requirement by 10%
**Recommendations for Managing Patients With Diabetes in the Hospital Setting**

Antihyperglycemic Therapy

- **Insulin**
  - Recommended

- **OADs**
  - Not Generally Recommended

- **IV Insulin**
  - Critically ill patients in the ICU

- **SC Insulin**
  - Non-critically ill patients

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**Oral Agents in the Hospital**

*Oral agents can be continued in stable patients with normal nutritional intake, normal blood glucose levels, and stable renal and cardiac function. However, otherwise not recommended in inpatient setting.*

- **Disadvantages of most oral agents:** Slow-acting/difficult to titrate
  - Sulfonyureas are a major cause of severe hypoglycemia
  - Metformin is contraindicated in settings of decreased renal blood flow, eg. Use of contrast dye, CHF, dehydration
  - Thiazolidinediones are associated with edema and CHF
Diabetes and Hyperglycemia Require Proactive Management

*Diabetes requires proactive management in all hospital patients. There are no “autopilot” insulin regimens

*Insulin is a “high alert” medication that is frequently associated with medication errors in the hospital, and JCAHO considers insulin to be one of the highest risk medications in the hospital (JCAHO Website, 2006)

What is the “Best Practice” for Managing Diabetes and Hyperglycemia in the Hospital?

*The answer is anticipatory, physiologic insulin dosing, prescribed as a basal/bolus insulin regimen

*This means giving the right type of insulin, in the right amount, at the right time, to meet the insulin needs of the patient

*Not ‘Sliding Scale Insulin’
During hospitalization
*Any patient with blood glucose levels consistently above the target range

Immediately at the time of admission
*All patients with type 1 diabetes
*Patients with type 2 diabetes if...
  *They are known to be insulin-requiring
  *They are known to be poorly controlled despite treatment with significant doses of oral agents
  *They are known to require high doses of oral agents that will be held in the hospital

### Physiologic Insulin Secretion: Basal/Bolus Concept

- **Suppresses Glucose Production Between Meals & Overnight**

  **The 50/50 Rule**
Providing Exogenous Basal Insulin

*Long-acting, non-peaking insulin is preferred as it provides continuous insulin action, even when the patient is fasting

*Required in ALL patients with type 1 diabetes

*Many patients with type 2 diabetes will require basal insulin in the hospital

*Can be estimated to be about 1/2 of the total daily dose of insulin (TDD)

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Which Insulins are Best for Basal Coverage?

- NPH
- Detemir (Levemir)
- Glargine (Lantus)
- Regular
- Lispro (Humalog)
- Aspart (Novolog)
- Glulisine (Apidra)
- Inhaled insulin

![Insulin Effect Graph](image)
Providing Exogenous Nutritional Insulin

*Usually given as rapid-acting analogue (preferred in most cases) or regular insulin, for those patients who are eating meals
*Must be matched to the patient’s nutrition
*Should not be given to patients who are not receiving nutrition (e.g. NPO)
*Can be estimated to be about ½ of the total daily dose of insulin (TDD)

Providing Exogenous Correctional Insulin

*Correctional insulin is extra insulin that is given to correct pre-existing hyperglycemia
*Usually rapid-acting or regular insulin (usually the same as the nutritional insulin)
*Often written in a “stepped” format that is used in addition to basal and nutritional insulin
*Customized to the patient using an estimate of the patient’s insulin sensitivity
*If correctional insulin is required consistently, or in high doses, it suggests a need to modify the basal and/or nutritional insulin doses
Using Exogenous Insulin to Imitate Physiologic Insulin Secretion: Summary

*Basal insulin: Use non-peaking, longer acting insulins
  - Glargine or detemir are preferred
  - NPH also possible

*Nutritional insulin: Depends on the type of nutrition
  - Rapid-acting insulin is preferred when patients are eating meals
  - Regular insulin also possible

*Correctional insulin: Use rapid-acting (or regular) insulin
  - Usually the same as the nutritional insulin

A Stepwise Approach to Physiologic Insulin Dosing in the Hospital

1. Decide if patient is appropriate for the subcutaneous insulin and discontinue oral anti-diabetic agents

2. Calculate the estimated total daily dose (TDD) of insulin

3. Determine the distribution of the TDD between basal and nutritional insulin based on nutrition regimen.

4. Re-evaluate & adjust the TDD daily based on the glycemic control of the previous 24h
**STEP 2: Estimate the Amount of Insulin the Patient Would Need Over One Day. If Getting Adequate Nutrition = Total Daily Dose (TDD)**

*For newly diagnosed patients, older patients, patients with renal insufficiency or those who are frail, do a conservative weight-based calculation*

*TDD = 0.2 units x Wt in Kg*

Example: 0.2 X 100 kg = 20 units

* If patient continues to have CBGs > 180, increase TDD by 10%

* If patient has two episodes of hypoglycemia (< 100) reduce TDD by 10%

**STEP 2: Estimate the Amount of Insulin the Patient Would Need Over One Day. If Getting Adequate Nutrition = Total Daily Dose (TDD)**

*For patients already treated with insulin, consider the patient’s preadmission subcutaneous regimen and glycemic control on that regimen*

*Weight-based estimate:*

*TDD = 0.4 units x Wt in Kg*

* Adjust down to 0.3 units x Wt in Kg for those with hypoglycemia risk factors, including kidney failure, type 1 diabetes (especially if lean), frail/low body weight/ malnourished elderly, or insulin naïve patients*

* Adjust up to 0.5-0.6 units (or more) x Wt in Kg for those with hyperglycemia risk factors, including obesity and high-dose glucocorticoid treatment*
**STEP 2: Decide Which Components of Insulin the Patient Will Require, and Which Percentage of the TDD Each Should Represent**

*Remember 50/50 rule*
- Basal insulin can generally be estimated to be 1/2 of the TDD
- Nutritional insulin makes up the remaining 1/2 of the TDD

*Points to consider*
- In most cases, basal insulin should be provided
- In most cases, well-designed corrective insulin regimens should be provided
- When a patient is not receiving nutrition, nutritional insulin should not be given
- Nutritional insulin needs must be matched to the actual nutritional intake

**STEP 3: Assess the Patient’s Nutritional Situation**

*Eating meals or receiving bolus tube feeds*
*Eating meals but with unpredictable intake*
*Getting continuous tube feeds*
*Getting tube feeds for only part of the day*
*Getting parenteral nutrition*
*NPO*
**STEP 4: Assess Blood Glucoses at Least Daily, Adjusting Insulin Doses as Appropriate**

*2 readings above 180 are considered uncontrolled*
*Blood glucose targets can only be achieved via continuous management of the insulin program*
*There is no “autopilot” insulin regimen for a hospitalized patient!*
*Know the previous days numbers*
*Know the previous day’s total daily insulin requirements*

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**STEP 4: Assess Blood Glucoses at Least Daily, Adjusting Insulin Doses as Appropriate**

*Hyperglycemia*
*Use previous correction day scale*
*10/20/30/40 rule*
*Adjust based on which values are elevated*

*Hypoglycemia*
*If hypoglycemic event, evaluate cause and adjust*
*If under 100 x2 back off insulin by 10%*
56 year old woman with DM2 admitted with a diabetes-related foot infection which may require surgical debridement in the near future, eating regular ADA meals.

- Weight: 100 kg
- Home medical regimen: Glipizide 10 mg po qd, Metformin 1000 mg po bid, and 20 units of NPH q HS
- Control: A recent HbA1c is 11.3%, POC glucose in ED 271 mg/dL

What are your initial orders?

1. You put the patient on the ‘Insulin Order Set’
2. regular ADA diet
3. moderate dose correctional scale
4. 10 units of glargine q HS
5. 3 units Lispro AC

Make sure the orders include:
* When will the CBGs be checked?
* Exactly what insulin is scheduled and at what times?
* If the patient is hypoglycemic, what should happen?
First AM CBGs for 4 days were 76, 63, 80, 69
His CBGs trended mildly upward during the day.
What is the problem?

Barriers to Glycemic Control

* Steroids both oral and IV
* Tube feedings
* TPN
* Infections
* Noncompliance with dietary regime
*Barriers to Good Glycemic Control
Oral Steroids

*Glycemic goals remain the same: <180
*Glargine nor lispro may not work well in these cases
*NPH has about the same duration of action as prednisone

Case Study 1
**Initial Order**

*Determine the total daily insulin dose of an insulin naïve person.*

\[ 67\text{kg} \times 0.2 = 13.4 / 2 = 6.7 / 3 = 2.2 \]

Glargine 7 units q HS and Lispro 2 units AC TID

Since her CBGs are trending upward throughout the day, you could also step up her insulin doses as follows:

- Breakfast - Lispro 2 units AC
- Lunch - Lispro 3 units AC
- Dinner - Lispro 4 units AC

**Subsequent Adjustments**

Add all the insulin received the day before including the basal, nutritional and correctional; divide by 2 to calculate the 50/50 split; divide the second value by 3 to determine the amount of insulin for meals.

Previous day’s insulin - Glargine 7 units
  - Nutritional 9 units
  - Correctional 26 units

TDD = 42 units
42 divided by 2 = 21 units divided by 3 = 7
Glargine 21 units; Lispro 7 units AC
Barriers to Good Glycemic Control
Oral Steroids

Oral prednisone
Nutrition
“Steroid” Hypoglycemia

Basal glucose production

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Oral Prednisone
NPH

Basal Insulin

|     | 8 am | 12 noon | 4 | 8 | 12 mdnt | 4 | 8 |
*If patient is taking basal/bolus already
  • Continue same regimen
  • Order prednisone as single AM dose daily

*Day 1 of prednisone: establish that prednisone hyperglycemia occurs (cover with correction)

*Day 2: add AM dose of NPH and titrate up to cover daytime hyperglycemia
  • Use NPH dose equal to ½ sum of correction for day 1
**Insulin Adjustment with Taper**

* Achieve good control with NPH
* Reduce insulin at same time or day before the reduction in prednisone
* Calculate how much NPH is being used to cover 1mg prednisone
  • 40 units of NPH needed for 30mg prednisone
  • \( \frac{40 \text{ units}}{30 \text{ mg}} = 1.3 \text{ units of NPH per mg prednisone} \)
* Reduce insulin accordingly
  • Prednisone decrease from 30 to 20, NPH reduce by 1.3 units \( \times 10 \text{ mg} = 13 \text{ mg daily} \)
* Discontinue NPH when under 10 units

**Barriers to Good Glycemic Control Tube Feedings**

* Determine if the patient has a Dobhoff or a PEG tube.
* If they are using the Dobhoff, there is a risk of clogging of the tube, misplacement or the patient pulling out the tube.
* In this case
  • Order the CBGs every 4 hours
  • Determine the TDD of insulin depending on the criteria discussed earlier
  • Divide the TDD by 2; the other half by 6

The TDD is 48

\[
\frac{48}{2} = 24 \\
\frac{24}{6} = 4
\]

Glargine 24 units q HS
Lispro nutritional 4 units every 4 hours
Lispro correctional
Barriers to Good Glycemic Control

*TPN presents challenges to glycemic control.
*Insulin frequently added to TPN bags; can be problematic
*Insulin tends to adhere to the lining of the plastic tubing
*Providers need to continue monitoring CBGs and add insulin to correct the elevated CBGS that are not being covered by the insulin in TPN

Glycemic Control Points

*Above 180 twice is ‘uncontrolled DM’ and a change needs to be made in insulin management
*Use of correction scale is sign of a treatment failure
*Uncontrolled DM should be on all 3 insulins
*Avoid clinical inertia, make changes to insulin
*Check MAR and administration times
Identify, monitor, and treat all patients with hyperglycemia.
* Obtain a HgA1c on all patients with diabetes or hyperglycemic patients.
* Obtain accurate record of home antiglycemic medications including names, doses and frequencies.
* Identify financial/social barriers to outpatient management
* Involve diabetes educators and social work as needed.
* If a patient’s HgA1C is > 10 at admission, a basal insulin will be required until the HgA1C drops < 10.
* If the patient is uncontrolled and is taking the highest amounts of two or more antiglycemic oral agents, insulin therapy should be considered.

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Common Barriers for Home Transition

*Common social issues
*Poor home support
*Transportation issues
*Drug or alcohol abuse
*Common financial barriers
*No insurance
*High deductibles

Summary

Understanding these basic principles of physiologic, anticipatory insulin will allow clinicians to formulate rational insulin regimens in virtually any clinical situation!
Key Review Articles

- American Diabetes Association (2013). Executive Summary: Standards of Medical Care in Diabetes - 2013. *Diabetes Care*, 35(supplement 1), S 4 - S 10
