Inpatient Management of Diabetes Mellitus

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Disclosure

• Jessica Garza does not have any actual or potential conflicts of interest in relation to this presentation.
Objectives

• Review treatment recommendations for inpatient glycemic control.

• Create a glycemic treatment plan for an diabetic inpatient.
Patient Case

• 56 y/o female with type 2 diabetes (T2DM) is admitted to the medical-surgical unit for treatment of community acquired pneumonia.
• Home medications: metformin and glipizide
• Prior HbA1c: 8.5%

Questions to Consider:

1. What is this patient’s glycemic target while hospitalized?
2. What should we do with this patient’s home medications?
3. Should insulin therapy be initiated?
Diabetes

• In 2010, diabetes was the 2nd leading cause of hospitalization.

• Diabetes is the leading cause of blindness and end stage renal disease in the United States.

• In 2012, $245 billion U.S. dollars were associated with diabetes management and complications.

Prevalence of Diabetes

Hospitalizations with Diabetes as any Diagnosis

Acute Illness and Hyperglycemia

Stress hyperglycemia may also exacerbate illness.

Medication Precipitators of Hyperglycemia

• Glucocorticoids
• Octreotide
• Vasopressors
• Parenteral/enteral nutrition
• Dextrose containing large volume parenterals
Hyperglycemia

- Impaired wound healing
- Infections
- Hyperglycemic crisis
- Other associations:
  - Increased LOS, complications, transfer to ICU, cost

Hypoglycemia

- Seizures
- Arrhythmias
- Confusion
- Coma
- Death

Inpatient Diabetes Management

- Hyperglycemia is common in hospitalized patients with or without history of diabetes

- Controversial: Hyperglycemia is a marker of poor outcomes OR patients with hyperglycemia are more critically ill

- Improved glycemic control has shown improved clinical outcomes in the hospital
Glucose Control In Critical Care
**Intensive vs. Conventional Insulin**

- **Van den Berghe MICU**
  - Medical ICU: target 80-110 vs. 180-215 mg/dL
  - Hypoglycemia: 18.7% vs. 3.1%, \( p < 0.001 \)

- **Van den Berghe SICU**
  - Surgical ICU: target 80-110 vs. 180-200 mg/dL
  - Hypoglycemia: 1% vs. 5%

- **High-level ICU care with established DM program**

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NICE-SUGAR: Intensive vs. Conventional Glycemic Control

90 Day Mortality

- Intensive Therapy: 27.5%
- Conventional Therapy: 24.9%

Severe Hypoglycemia

- Intensive Therapy: 6.8%
- Conventional Therapy: 0.5%

Intensive vs. Conventional Insulin

Meta-Analysis: Griesdale, et al

ICU Glycemic Targets Summary

• Inpatient hyperglycemia is associated with poor clinical outcomes

• AACE/ADA recommended glycemic goals:
  • Threshold for starting insulin: 180 mg/dL
  • Maintain blood glucose: 140-180 mg/dL
  • No longer recommend blood glucose < 110 mg/dL

Glucose Control in Medical-Surgical Units
SLIDING SCALE ONLY

Glucose-Unit Base Meter-RALS™

BASAL/BOLUS INSULIN

RALS = Remote Automated Laboratory System.

Schmeltz, LR. LabMedicine. 2011;42(7):427-34.
Basal-Bolus vs. Sliding Scale (SSI)

Glycemic Control

% of Pts w/ BG <140 mg/dL

RABBIT 2 Trial

Basal/Bolus (Glargine and Glulisine) vs. SSI

- Basal/Bolus (Glargine and Glulisine): 66% (p = 0.03)
- SSI: 38%

RABBIT 2 Surgery

- Basal/Bolus (Glargine and Glulisine): 55% (p < 0.001)
- SSI: 33%

References:

Basal-Bolus vs. Sliding Scale

Hypoglycemia

<table>
<thead>
<tr>
<th>% of Pts w/ BG &lt; 60 mg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>70%</td>
</tr>
<tr>
<td>60%</td>
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<tr>
<td>50%</td>
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<tr>
<td>40%</td>
</tr>
<tr>
<td>30%</td>
</tr>
<tr>
<td>20%</td>
</tr>
<tr>
<td>10%</td>
</tr>
<tr>
<td>0%</td>
</tr>
</tbody>
</table>

RABBIT 2 Trial

- Basal-Bolus: 0.4%
- SSI: 0.2%

RABBIT 2 Surgery

- Basal-Bolus: 11.5%
- SSI: 1.9%

p = 0.005

Non-ICU Glycemic Targets Summary

- AACE/ADA recommended glycemic goals:
  - Pre-meal glucose < 140 mg/dL
  - Random glucose < 180 mg/dL
  - Blood glucose < 110 mg/dL no longer recommended.

Pharmacologic Glycemic Management
Insulin Options

- **Rapid acting:** Insulin lispro, aspart or glulisine
- **Short acting:** Regular Insulin
- **Intermediate acting:** NPH
- **Long acting:** Insulin detemir, Insulin glargine

Image from: http://tmedweb.tulane.edu/pharmwiki/doku.php/insulin_regimens
Modifying Home Insulin Therapy

**Type 1**
- Rapid DKA unless basal and correction insulin.
- Continue home dose unless markedly hypoglycemic.
- Ask nursing to hold mealtime if not eating.

**Type 2**
- Consider empiric increase if BG >180 mg/dL.
- Continue home dose if 140-180 mg/dL.
- Consider 20% reduction if <140 mg/dL.
- Consider 50% reduction if hypoglycemic.
## Initiating New Insulin Regimen

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Total Daily Dose Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin sensitivity</td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>0.3 units/kg/day</td>
</tr>
<tr>
<td>Elderly</td>
<td></td>
</tr>
<tr>
<td>Hemodialysis or renal insufficiency</td>
<td></td>
</tr>
<tr>
<td>Normal weight</td>
<td>0.4 units/kg/day</td>
</tr>
<tr>
<td>Obese</td>
<td></td>
</tr>
<tr>
<td>Insulin resistance</td>
<td>0.5 – 0.6 units/kg/day</td>
</tr>
<tr>
<td>Glucocorticoids</td>
<td></td>
</tr>
</tbody>
</table>

Creating a Basal-Bolus Insulin

<table>
<thead>
<tr>
<th>Step</th>
<th>Basal-Bolus Insulin for a Hospitalized Patient</th>
<th>Example: 80 kg patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Total Daily Dose (TDD)</td>
<td>80 kg = 40 units daily</td>
</tr>
<tr>
<td></td>
<td>• 0.4 units/kg/day</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>Basal Insulin</td>
<td>50% of 40 units = 20 units daily</td>
</tr>
<tr>
<td></td>
<td>• 50% of TDD</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>Mealtime Insulin</td>
<td>50% of 40 units = 20 units daily</td>
</tr>
<tr>
<td></td>
<td>• 50% of TDD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Split between 3 meals</td>
<td>20 units/3 meals = 6 units AC</td>
</tr>
<tr>
<td>Step 4</td>
<td>Correction Scale</td>
<td>Based on insulin resistance</td>
</tr>
</tbody>
</table>

Selecting Correctional Insulin

<table>
<thead>
<tr>
<th>Blood glucose (mg/dL)</th>
<th>Range A (units)</th>
<th>Range B (units)</th>
<th>Range C (units)</th>
<th>Range D (units)</th>
<th>Custom Range (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>66-100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>101-140</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>141-170</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>171-200</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>201-250</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>251-300</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Greater than 300</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

- **T1DM (sensitive), or non-diabetic**
- **“Standard” T2DM, mild insulin resistance**
- **“Resistant” T2DM on high insulin dose or steroids**
- **“D” = Danger: usually too high, add more basal insulin, glycemic roller coaster**
T1DM & T2DM Patients Requiring Insulin

**NPO**

**Basal:** home dose OR 0.2-0.4 unit/kg/day

**Correctional:** based upon sensitivity parameters

**BASAL INSULIN**

**MEALTIME INSULIN**

**CORRECTIONAL INSULIN**

**Oral Intake**

**Basal:** home dose OR 0.2-0.4 unit/kg/day

**Mealtime:** home dose OR 0.05-0.1 unit/kg/meal

**Correctional:** based upon sensitivity parameters

Titrating Insulin Therapy

**Basal**
- Titrate by 50% of correctional requirements if no hypoglycemia has occurred

**Mealtime**
- Initiate if BG increases with each meal
- Titrate by 1-2 units per meal

**Correctional**
- Consider moving up a “scale” for hyperglycemia that does not correct despite titrating basal & mealtime
- Consider moving down a “scale” for hypoglycemia after correctional administration
# Oral Anti-Diabetic Medications

<table>
<thead>
<tr>
<th>Medication/Class</th>
<th>Concerns with Hospital Administration</th>
</tr>
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<tbody>
<tr>
<td>Sulfonylureas</td>
<td>Hypoglycemia</td>
</tr>
<tr>
<td>Thiazolidinedione (TZD)</td>
<td>Fluid retention, heart failure</td>
</tr>
<tr>
<td>Metformin</td>
<td>Lactic acidosis, renal insufficiency, IV contrast</td>
</tr>
<tr>
<td>α-glucosidase inhibitors</td>
<td>Ineffective, unresponsive hypoglycemia</td>
</tr>
<tr>
<td>Glucagon like peptide-1 agonist (GLP-1)</td>
<td>$$$, ↑ risk of GI effects</td>
</tr>
<tr>
<td>Dipeptidyl peptidase IV inhibitors</td>
<td>Renal insufficiency, electrolyte abnormalities, hypotension</td>
</tr>
<tr>
<td>Sodium-glucose cotransporter 2 inhibitors (SGLT2)</td>
<td></td>
</tr>
</tbody>
</table>

# Oral Anti-Diabetic Medications

<table>
<thead>
<tr>
<th>Medication/Class</th>
<th>Recommendations upon hospitalization</th>
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</thead>
<tbody>
<tr>
<td>Sulfonylureas</td>
<td>Discontinue, especially if acute renal insufficiency and/or NPO</td>
</tr>
<tr>
<td>Thiazolidinedione (TZD)</td>
<td>Discontinue, especially if edematous</td>
</tr>
<tr>
<td>Metformin</td>
<td>Discontinue, medico-legal risk</td>
</tr>
<tr>
<td>α-glucosidase inhibitors</td>
<td>Discontinue, ineffective</td>
</tr>
<tr>
<td>Glucagon like peptide-1 agonist</td>
<td>Continue if medically stable/glycemic controlled</td>
</tr>
<tr>
<td>Dipeptidyl peptidase IV inhibitors</td>
<td>Discontinue if significant GI disturbances</td>
</tr>
<tr>
<td>Sodium-glucose cotransporter 2 inhibitors (SGLT2)</td>
<td>Discontinue, especially if hypotensive or renal dysfunction (decreased efficacy)</td>
</tr>
</tbody>
</table>
T2DM Patients Previously Controlled on Oral Agents

NPO
Discontinue oral agents
*INITIATE Correctional*: based upon sensitivity parameters

THEN
• **Basal**: Add/titrare by 50% of correctional need
• Consider mealtime bolus if BG “stacking” occurs with meals

Oral Intake
Continue **select** oral agent
*INITIATE Correctional*: based upon sensitivity parameters

THEN
• **Basal**: Add/titrare by 50% of correctional need
• Consider mealtime bolus if BG “stacking” occurs with meals

T2DM Patients Previously Un-Controlled on Oral Agents

**NPO**
- Discontinue oral agents
- **INITIATE**
  - **Basal**: 0.1-0.2 unit/kg/day
  - **Correctional**: based upon sensitivity parameters

  **THEN**
  - Add/titrate by 50% of correctional insulin need
  - Consider mealtime bolus if BG “stacking” occurs with meals

**BASAL INSULIN**

**ORAL INGREDIENT**
- Continue *select* oral agent
- **INITIATE**
  - **Basal**: 0.1-0.2 unit/kg/day
  - **Correctional**: based upon sensitivity parameters

  **THEN**
  - Add/titrate by 50% of correctional insulin need
  - Consider mealtime bolus if BG “stacking” occurs with meals

Hypoglycemia Concerns

• Stopping or holding enteral or parenteral feeds

• Over-reliance on correctional insulin: hypo/hyperglycemia rollercoaster

• Resolving stress-related hyperglycemia

• Tapering glucocorticoids
Patient Case

• 56 y/o female with T2DM is admitted to the Medical/Surgical unit for treatment of community acquired pneumonia.
• Home medications: metformin and glipizide
• Prior HbA1c: 8.5%
• Current BG: 200, 196 mg/dL
• Diet: Diabetic

Which of the following is the BEST answer?
A. Discontinue metformin & glipizide
B. Continue metformin & glipizide
C. Continue metformin & glipizide; begin correctional insulin
D. Discontinue metformin & glipizide; begin basal and correctional insulin
QUESTIONS