Transition of Care in Hospitalized Patients with Hyperglycemia and Diabetes

Guillermo E Umpierrez, MD, FACP, FACE
Professor of Medicine
Emory University School of Medicine
Director, Diabetes and Endocrinology Section
Grady Health System
Atlanta, Georgia

Learning Objectives

• Describe strategies for treating and prevent rebound hyperglycemia during the transition from ICU to regulars floor
• Outline processes and procedures for an appropriate transition from the hospital to outpatient care
Diabetes Epidemic in the U.S.

**US Population**

Diabetes prevalence quadrupled, from 5.5 million to 21.9 million between 1980-2014

![Graph showing diabetes prevalence quadrupled](http://www.cdc.gov/diabetes/statistics)

**Inpatient Diabetes**

- 23% of all discharges
- 8-9 million discharges
- Annual cost: $124 billion (2012)

![Graph showing inpatient diabetes](http://hcupnet.ahrq.gov/HCUPhot.jpg)


ADA. Diabetes Care. Mar 6 2013;

What Glucose Level Predicts Hospital Complications?

![Graph showing glucose level and hospital complications](http://www.ada.org)

N= 55,530 patients records in ICU and non-ICU, Emory University Hospitals. Composite of complications: pneumonia, acute renal or respiratory failure, acute MI, bacteremia, and death.

Umpierrez et al. Endocrine Society Annual Meeting, 2014
Hospital Mortality and Complications in Patients with Hyperglycemia and Diabetes

**ICU**

Mortality Risk Greater in Hyperglycemic Patients Without History of Diabetes

- No History Diabetes
- History Diabetes

<table>
<thead>
<tr>
<th>Mean BG (mg/dL)</th>
<th>Odd Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;300</td>
<td></td>
</tr>
<tr>
<td>222-149</td>
<td></td>
</tr>
<tr>
<td>146-175</td>
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</tbody>
</table>

**Non-ICU**

Mortality and Hospital Complications in General Surgery Patients

†p = 0.1;  *p = 0.001 #p = 0.017

Insulin is the Preferred Treatment for Hyperglycemia in the Hospital Setting

- Critically ill patients in the ICU: IV insulin infusion
- Non-critically ill patients: Basal + prandial regimen

ICU=intensive care unit; IV=intravenous

Why Insulin is the Most Appropriate Agent for Critically Ill Hospitalized Patients

Critically Ill Patients

IV Insulin

- Most potent glucose-lowering agent
- Rapidly effective
- Easily titratable (up or down)
- No real contraindications


Strategies for Achieving Glycemic Targets in the ICU

Transition from iv to sc insulin

Protocols

- T1DM
- T2DM
- Stress hyperglycemia


Transition From IV Insulin to SC Insulin

- IV insulin should be transitioned to SC insulin therapy when patient begins to eat and BG levels are stable
  - All patients with T1D
  - All patients with T2D treated with insulin prior to admission
  - Most patients with T2D treated with oral agents prior to admission
  - Most patients with stress hyperglycemia requiring CII at a rate ≥ 2 units/hour

Transition From IV Insulin to SC Insulin

- Because of short half-life of IV insulin, SC insulin should be administered prior to discontinuing the drip
  - NPH: 1-2 hours
  - Glargine and detemir: 2-4 hours
  - If short-acting insulin also administered, IV insulin may be able to be stopped sooner, eg, after 1 hour


Calculating the SC Insulin Dose

- Establish the 24-hour insulin requirement by extrapolating from the average IV insulin dose required over the previous 6–8 hours (if stable)
- Take 80% of the total daily dose (TDD) and give one half as an intermediate-acting or long-acting insulin for basal coverage and one half as a short-acting or rapid-acting insulin in divided doses before meal
  - (If patient is not eating, just give intermediate/long-acting insulin.)

Percent of Total Glucose Levels within the 80-140 Range on Glargine

Steps in the Initiation of a Basal-Bolus Insulin Regimen

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| Step 1 | Calculate estimated total daily dose of insulin (type 2 diabetes)  
- 0.2–0.3 unit/kg/day in patients >70 years and/or GFR <60 mL/min  
- 0.4 unit/kg/day if BG between 140 and 200 mg/dL and not meeting above criteria  
- 0.5 unit/kg/day if BG between 201 and 400 mg/dL and not meeting above criteria |
| Step 2 | Divide total daily dose (TDD) of insulin into 50% basal (long-acting insulin analog) and 50% nutritional (rapid-acting insulin analog) |
| Step 3 |  
- Give basal insulin (glargine/detemir) once daily or NPH twice daily at the same time each day  
- Give nutritional insulin (rapid-acting insulin analog) in 3 divided doses before each meal, so long as consistent carbohydrate intake is ensured. Rapid-acting insulin dosing should be held if a patient is unable to eat  
- Provide supplemental (correction) insulin in addition to basal and nutritional  
- Adjust insulin dose(s) according to results of bedside BG measurements |

Initiation of insulin must be individualized, and elderly residents may require a lower starting dose.
A diet with consistent carbohydrate intake should be emphasized in conjunction with a basal-bolus regimen

For additional weight-based dosing options, please see:
SC Insulin Administration

“Scheduled”

Basal + Bolus (Nutritional) + Correction

Long-acting insulin

Rapid-acting insulin

Correction

Total daily insulin needs

Basal

Nutritional


Transition from IV to SC Insulin

Basal-bolus Therapy

Basal Analog vs. NPH


2. Newton et al. Dean trial; IJCEM 2009


2. Newton et al. Dean trial; IJCEM 2009
Mean BG after surgery | % BG 80-140 mg/dl | BG < 60 mg/dl

<table>
<thead>
<tr>
<th></th>
<th>NPH/Regular</th>
<th>Glargine/Glulisine</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>188 ± 61</td>
<td>213 ± 76</td>
<td>0.234</td>
</tr>
<tr>
<td>Day 2</td>
<td>206 ± 71</td>
<td>220 ± 61</td>
<td>0.370</td>
</tr>
<tr>
<td>Day 3</td>
<td>207 ± 86</td>
<td>180 ± 80</td>
<td>0.417</td>
</tr>
<tr>
<td>Day 4</td>
<td>211 ± 63</td>
<td>158 ± 44</td>
<td>0.068</td>
</tr>
<tr>
<td>Day 5</td>
<td>190 ± 45</td>
<td>124 ± 41</td>
<td>0.068</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypoglycemia</th>
<th>NPH/Regular</th>
<th>Glargine/Glulisine</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with BG &lt;70 mg/dl, n (%)</td>
<td>5 (15)</td>
<td>14 (41)</td>
<td>0.03</td>
</tr>
<tr>
<td>Episodes of BG &lt;70 mg/dl, n</td>
<td>8</td>
<td>26</td>
<td>0.019</td>
</tr>
<tr>
<td>Patients with BG &lt;40 mg/dl, n (%)</td>
<td>1 (3)</td>
<td>2 (6)</td>
<td>NS</td>
</tr>
<tr>
<td>Episodes of BG &lt;40 mg/dl, n</td>
<td>1</td>
<td>2</td>
<td>NS</td>
</tr>
</tbody>
</table>

Data for glucose levels are means ± SD.

Umpierrez et al, Diabetes Care 32:1164–1169, 2009
Why Not Sliding Scale Insulin?

- **Definition**
  - Use of a mealtime insulin, typically regular insulin, as the sole insulin for managing a patient’s diabetes

- **Potential problems**
  - Poor control of hyperglycemia (does not address basal insulin needs)
  - Insulin “stacking”
  - Hypoglycemia

- Not preferred method of SC insulin delivery


Glucose Levels During Basal-bolus and SSI Treatment

Changes in BG concentration after the first day of treatment with basal-bolus with glargine once daily plus glulisine before meals (○) and with SSI 4 times daily (●). *P <0.001, †P = 0.02, ‡P = 0.01.

Glucose levels before meals and bedtime. Premeal and bedtime glucose levels were higher throughout the day in the SSI group (●) compared with basal-bolus regimen (○).

RABBIT-2 Surgery: Composite Hospital Complications and Outcomes: SSI vs Basal-bolus Insulin

ICU length of stay 3.19 vs 1.23 days; \( P = 0.003 \) SSI vs BB

Number of patients with complications:
- Sliding Scale Insulin
- Basal Bolus Insulin

- Wound infections: SSI 9, BB 11
- Pneumonia: SSI 3, BB 3
- Acute respiratory failure: SSI 5, BB 1
- Acute renal failure: SSI 4, BB 1
- Bacteremia: SSI 2, BB 1
- Mortality: SSI 1, BB 1
- Postsurgery ICU admission: SSI 19.6, BB 12.5

\*\( P = 0.003 \); \**P = 0.050.\n

Transition From Hospital to Outpatient Care
Clinical Inertia on Discharge Planning

Percentage of patients with uncontrolled diabetes discharged with no change in medications or follow-up HgbA1c within 60 days.

Griffith et al. JCEM, 97:2019–2026, 2006

Primary Medication Non-Adherence after Discharge from a General Internal Medicine Service

Care Processes:
Discontinuation of Antihyperglycemic Therapy After Acute Myocardial Infarction: Medical Necessity or Medical Error?

PREADMISSION GLYCEMIC CONTROL AND CHANGES TO DIABETES MELLITUS TREATMENT REGIMEN AFTER HOSPITALIZATION

SURVEY ON TRANSITION FROM INPATIENT TO OUTPATIENT FOR PATIENTS ON INSULIN: WHAT REALLY GOES ON AT HOME?
Discontinuation of Anti-Hyperglycemic Therapy at discharge in Patients with Acute Myocardial Infarction

• Among 217 diabetic patients with AMI, 25 (11.5%) were DC off anti-hyperglycemic therapy
• No clear reason for stopping therapy in 88% of patients
• Hyperglycemia is a marker of poor outcome and mortality in patients with AMI, thus these findings may represent an opportunity to improve the quality of care

Lovig et al. The Joint Commission Journal on Quality and Patient Safety 2012
Kosiborod et al, Diabetes Care 2012

Outcomes Associated with Insulin Therapy Disruption After Hospital Discharge among Patients with Type 2 Diabetes Mellitus Who Had Used Insulin Before and During Hospitalization

Time to the first all-cause hospital readmission among patients with T2D who were taking insulin before and during hospitalization and who had either continued insulin therapy or disrupted insulin therapy after hospital discharge.

Wu et al. Endocrine Pract 18:651-659, 2012
Transition From Hospital to Outpatient Care

- Preparation for transition to the outpatient setting should begin at the time of hospital admission
- Multidisciplinary team: bedside nurse, clinical pharmacist, registered dietitian, case manager
- Clear communication with outpatient providers is critical for ensuring safe and successful transition to outpatient management


Transition to Discharge

- Does patient have a glucose monitor for home use?
- Does patient know how to inject insulin and how to prevent and to treat hypoglycemia?
- Is patient clear about the diabetes therapy after discharge?
- Does patient have appropriate outpatient follow-up appointment with primary care or specialist?
“Survival Skills” to Be Taught Before Discharge

- Basic understanding of what diabetes is
- How and when to take diabetes medications
- Basic knowledge of effect of carbohydrates on glucose levels
- Recognition, treatment, and prevention of hypoglycemia
- Self-monitoring of BG and implication of results
- What to do during illness
- How to dispose of lancets and insulin syringes


Possibilities for Hospital Discharge
Hyperglycemia Regimen

Based on hemoglobin A1C:

- Home regimen
- Titration of home regimen
- Or new insulin regimen (if last option, simple regimen with aggressive patient education and prompt follow-up)
Use admission A1C to adjust therapy at discharge

- A1C < 7%
  - Re-start outpatient treatment regimen (OAD and/or insulin)

- A1C 7%-9%
  - Re-start outpatient oral agents and D/C on glargine once daily at 50% of hospital dose

- A1C >9%
  - D/C on basal bolus at same hospital dose
  - Alternative: re-start oral agents and D/C on glargine once daily at 80% of hospital dose

Discharge Insulin Algorithm


Umpierrez G et al, J Clin Endocrinol Metabol, 2012
Hospital Discharge Algorithm Based on Admission HbA1C for the Management of Patients with T2DM

Primary outcome:
- change in A1C at 4 wks and 12 wks after discharge

<table>
<thead>
<tr>
<th></th>
<th>All Patients</th>
<th>OAD</th>
<th>OAD + Glargine</th>
<th>Glargine+ Glulisine</th>
<th>Glargine</th>
</tr>
</thead>
<tbody>
<tr>
<td># patients, n (%)</td>
<td>224</td>
<td>81 (36)</td>
<td>61 (27)</td>
<td>54 (24)</td>
<td>20 (9)</td>
</tr>
<tr>
<td>A1C Admission, %</td>
<td>8.7±2.5</td>
<td>6.9±1.5</td>
<td>9.2±1.9</td>
<td>11.1±2.3</td>
<td>8.2±2.2</td>
</tr>
<tr>
<td>A1C 4 Wks F/U, %</td>
<td>7.9±1.7*</td>
<td>7.0±1.4</td>
<td>8.0±1.4ψ</td>
<td>8.8±1.8ψ</td>
<td>7.7±1.7</td>
</tr>
<tr>
<td>A1C 12 Wks F/U, %</td>
<td>7.3±1.5*</td>
<td>6.6±1.1</td>
<td>7.5±1.6*</td>
<td>8.0±1.6*</td>
<td>6.7±0.8*</td>
</tr>
<tr>
<td>BG&lt;70 mg/dl, n (%)</td>
<td>62 (29)</td>
<td>17 (22)</td>
<td>17 (30)</td>
<td>23 (44)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>BG&lt;40 mg/dl, n (%)</td>
<td>7 (3)</td>
<td>3 (4)</td>
<td>0 (0)</td>
<td>3 (6)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

* p< 0.001 vs. Admission A1C; ψp=0.08

**Revised Discharge Insulin Algorithm**

**Discharge Treatment**

- **A1C < 7%**
  - **A1C < 8%**
    - Re-start outpatient treatment regimen (OAD and/or insulin)

- **A1C 7%-9%**
  - **A1C 8%-10%**
    - Re-start outpatient oral agents and D/C on glargine once daily at 50% of hospital dose

- **A1C > 9%**
  - **A1C > 10%**
    - D/C on basal bolus at same hospital dose.
      - Alternative: re-start oral agents and D/C on glargine once daily at 80% of hospital dose


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**Non-Insulin Therapies in the Hospital**

- Which agents for which patients?
- Dipeptidyl peptidase 4 inhibitor alone or in combination with basal insulin
  - Well tolerated with similar glucose control and frequency of hypoglycemia compared with a basal–bolus regimen in general medicine and surgery patients
- Incretin agents do not cause hypoglycemia
- Need RCT evidence of safety and efficacy compared with standard therapies

Mean Daily BG During Treatment


Randomization Blood Glucose (<180 mg/dl and >180 mg/dl) and Mean Daily Glucose concentration

Summary

1. Diabetes is a common diagnosis in the hospital setting; hospitalization provides an opportunity to identify and improve glycemic control
2. The many transitions of care during hospitalization and back to the outpatient setting can create challenges to glycemic control
3. A team approach, medication reconciliation, and policies to manage hyperglycemia and insulin therapy can improve diabetes care
4. Patients with diagnosed diabetes or newly diagnosed diabetes may require changes to or intensification of therapy and appropriate education