Inpatient Management of Diabetes and Hyperglycemia

Guillermo E. Umpierrez, MD, CDE, FACP, FACE
Professor of Medicine
Emory University School of Medicine

Director, Diabetes & Endocrinology Section
Grady Health System
<table>
<thead>
<tr>
<th>External Industry Relationships *</th>
<th>Company Name(s)</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity, stock, or options in biomedical industry companies or publishers</td>
<td>BMJ Open Diabetes Research &amp; Care</td>
<td>Editor-in-Chief</td>
</tr>
<tr>
<td>Industry funds to Emory University for my research</td>
<td>Novo Nordisk Astra Zeneca Dexcom</td>
<td>Investigator-Initiated Research Projects</td>
</tr>
<tr>
<td>Industry Advisory/Consultant activities</td>
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Hyperglycemia in Non-ICU Settings

Lecture Agenda

1. Scope of the Problem:
   - Epidemiology, glycemic targets, and impact of hyperglycemia on clinical outcomes

2. What’s new on the management of hyperglycemia in non-ICU settings?
   - Insulin regimens – Which and how to start?
   - Non-Insulin regimens – are they safe & effective?
   - Antidiabetic regimens after discharge

3. New areas of clinical research & technology
Lecture Agenda

Case presentation:
- A case of DM/hyperglycemia in general wards
- A case of DM/hyperglycemia + CAD/ heart failure
- A case of DM and steroid-induced diabetes
- A case of diabetes during nutrition support
- Hospital discharge regimens
Diabetes Epidemic in the U.S.

US Population

- 30.2 million people

Prevalence quadrupled, from 5.5 million to 21.9 million between 1980-2014
- 12.6% (2011-2014) of US adults

Hospital Diabetes

- 7.2 million hospital discharges with diabetes
- 23% of all discharges; 14.2 million ER visits/year
- Annual cost: $327 billion (2017)
- Hospital inpatient care (30% of the total medical cost),


ADA. Diabetes Care. 2018
Distribution of patient-day-weighted mean POC-BG values for ICU

Data from ~12 million BG readings from 653,359 ICU patients - mean POC-BG: 167 mg/dL

Swanson et al. Endocrine Practice 2011
What Glucose Level Predicts Hospital Complications?

Composite of complications: pneumonia, acute renal or respiratory failure, acute MI, bacteremia, and death.

N = 55,530 patients records in ICU and non-ICU, Emory University Hospitals.

Umpierrez et al. ADA Scientific Meeting, 2017
Thirty Day Mortality and hospital Complications in diabetic and non-diabetic subjects Undergoing Non-Cardiac Surgery

3,184 non-cardiac surgery patients consecutively admitted to Emory University Hospital between 1/2007 and 6/2007.

†p = 0.1
* p = 0.001
#p = 0.017

A Frisch & Umpierrez et al. Diabetes Care, May 2010
Adverse Events Stratified by Perioperative Hyperglycemia

Diabetes

- Hospital Deaths
- Re-operations
- Composite Infections

No Diabetes

Proportion of Patients (%)

BG at any point on the day of surgery, post-op day 1 and 2
N= 11,633, colorectal and bariatric surgery;
29.1% with hyperglycemia

* P <0.01
§ p <0.05

Definition of Stress Hyperglycemia: greater than 140 mg/dl or greater than 180 mg/dl?
Stress Hyperglycemia

↑ Counterregulatory hormones
- Cortisol
- Catecholamines
- Glucagon
- Growth Hormone

↑ Glucose production

↑ Oxidative stress and Pro-inflammatory cytokines
- TNF α, IL-6 and IL-1β

↓ Glucose utilization

↑ Glucose
↑ FFAs

↑ Lipolysis

FFAs

Link Between High Blood Glucose and Poor Outcomes: Potential Mechanisms

Metabolic stress response
- Stress hormones and peptides
- Glucose
- Insulin
- FFA
- Ketones
- Lactate

Cellular injury/apoptosis
- Inflammation
- Tissue damage
- Altered tissue/wound repair
- Acidosis
- Infarction/ischemia

Immune dysfunction

Infection dissemination

Reactive O₂ species
- Transcription factors
- Secondary mediators

Prolonged hospital stay
- Disability
- Death

Glycemic Targets in Non-Critical Care Setting

1. Premeal BG target of <140 mg/dl and random BG <180 mg/dl for the majority of patients

2. 2018 American Diabetes Association – glucose target 140-180 mg/dl for most patients with T2D

3. Glycemic targets be modified according to clinical status.
   - Patients with terminal illness <180-200 mg/dl

4. For avoidance of hypoglycemia, therapy should be reassessed when BG<100 mg/dl

2019 Recommendation: Keep BG <180 mg/dl!

ADA/AACE Guidelines, Diabetes Care 2009;
Endocrine Society. J Clin Endocrinol Metabol, 2012; Under Revision 2018
2018 Standard of Diabetes Care, # 14, Hospital Management of Diabetes, Diabetes Care 2018
Case # 1. DM & Community acquired pneumonia

- A 48-year-old male with an 8-year history of diabetes was admitted with a 3-day history of fever, cough, and right lower lobe pneumonia on chest x-ray. He was previously treated with metformin and sulfonylurea.
- Laboratory results are as follows: BG 264 mg/dL, creatinine 1.4 mg/dL, and HbA1c: 8.4%.

Given this patient’s history and laboratory values, what is the best treatment option for glycemic management?

a) Continue oral antidiabetic agents?
b) Basal or basal bolus regimen
c) Split-mixed regimen with NPH/regular?
d) Premixed insulin twice daily
Antihyperglycemic Therapy

**Insulin**
Recommended

**OADs**
Not Generally Recommended

2. *Diabetes Care*. 2009;31(suppl 1):S1-S110..
Basal Bolus vs. Sliding Scale Regular Insulin for the Management of Non-ICU Patients With Type 2 Diabetes: Rabbit Studies

Inpatient Management in non-ICU

- Basal Bolus Insulin Analogs
- Sliding Scale Regular Insulin
Rabbit 2 Trial: Changes in Glucose Levels With Basal-Bolus vs. Sliding Scale Insulin

Hypoglycemia rate:
- Basal Bolus Group:
  - BG < 60 mg/dL: 3%
  - BG < 40 mg/dL: none
- SSRI:
  - BG < 60 mg/dL: 3%
  - BG < 40 mg/dL: none

• Sliding scale regular insulin (SSRI) was given 4 times daily
• Basal-bolus regimen: glargine was given once daily; glulisine was given before meals.
  0.4 U/kg/d x BG between 140-200 mg/dL
  0.5 U/kg/d x BG between 201-400 mg/dL

RABBIMIT-2 Surgery Trial:

- Research Question:
  T2DM on diet, oral agents or insulin treatment, does treatment with basal bolus regimen with glargine and glulisine is superior to SSRI?

Composite of hospital complications: wound infection, pneumonia, respiratory failure, acute kidney injury, and bacteremia

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011
Postoperative Complications

* Composite of hospital complications: wound infection, pneumonia, respiratory failure, acute renal failure, and bacteremia.

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011
# Hospitalization Outcomes and Costs

<table>
<thead>
<tr>
<th></th>
<th>All (n= 180)</th>
<th>Basal Bolus (n= 88)</th>
<th>SSI (n= 92)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of hospital stay, days</td>
<td>7.9 ± 5.5</td>
<td>7.3 ± 5.1</td>
<td>8.5 ± 5.9</td>
<td>0.15</td>
</tr>
<tr>
<td>Patients with complications, n (%)*</td>
<td>28 (16%)</td>
<td>6 (7%)</td>
<td>22 (24%)</td>
<td>0.002</td>
</tr>
<tr>
<td>Postsurgical ICU admission, n (%)</td>
<td>23 (13%)</td>
<td>10 (11%)</td>
<td>13 (14%)</td>
<td>0.66</td>
</tr>
<tr>
<td>Total hospitalization costs, USD</td>
<td>24457 ± 18359</td>
<td>23226 ± 18745</td>
<td>25641 ± 17991</td>
<td>0.09</td>
</tr>
<tr>
<td>Inpatient cost per day</td>
<td>4541 ± 18359</td>
<td>3907 ± 6606</td>
<td>3724 ± 4020</td>
<td></td>
</tr>
</tbody>
</table>

Treatment with BB compared with SSI reduced average total inpatient costs per day by $751 (14%; 95% confidence interval 20–4).

Data presented as mean ± SD

*Wound infections, pneumonia, acute respiratory failure, acute renal failure, bacteremia

Inpatient Management in non-ICU Setting

Basal Bolus Insulin Analogs

NPH and Regular Insulin
DEAN Trial: Detemir + Aspart vs. NPH + Regular

![Graph showing BG levels over Duration of Therapy](image)

Data are means ± SEM.

Basal-bolus regimen: detemir was given once daily; aspart was given before meals.

NPH/regular regimen: NPH and regular insulin were given twice daily, two thirds in AM, one third in PM.

Prevalence of Hypoglycemia in Patients Treated with Human and Analogs

<table>
<thead>
<tr>
<th></th>
<th>ALL N=134</th>
<th>Analogs N=66</th>
<th>Human n=68</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Hypoglycemia</td>
<td>37</td>
<td>35</td>
<td>38</td>
<td>$p=0.68$</td>
</tr>
<tr>
<td>Severe hypoglycemia</td>
<td>16</td>
<td>7.6</td>
<td>25</td>
<td>$p=0.08$</td>
</tr>
<tr>
<td>Patients within ≥2 episodes, n (%)</td>
<td>19</td>
<td>10</td>
<td>16</td>
<td>$p=0.2$</td>
</tr>
</tbody>
</table>

A 62-year-old female with a 10-year history of type 2 diabetes treated with metformin 500 mg two times per day and sitagliptin 100 mg/dL. The patient has a history of coronary artery disease and an acute myocardial infarction in 2016. She was admitted with increasing shortness of breath, paroxysmal nocturnal dyspnea, and orthopnea.

A physical exam showed S3 and + pedal edema. A chest x-ray was consistent with heart failure.

Laboratory results are as follows: BG 214 mg/dL, creatinine 1.2 mg/dL, and HbA1c: 7.8%.
Case # 2. DM & CAD/ heart failure

- A 62-year-old female with a 10-year history of T2D treated with metformin 500 mg b.i.d. and sitagliptin 100 mg/dL. The patient has a history of coronary artery disease and an acute myocardial infarction in 2016. She was admitted with increasing shortness of breath, paroxysmal nocturnal dyspnea, and orthopnea.

- Physical exam showed 1S3 and 21 pedal edema. A chest x-ray was consistent with congestive heart failure. Laboratory results are as follows: BG 214 mg/dL, creatinine 1.2 mg/dL, and HbA1c 8.0%.

What is the best treatment option for glycemic management?

a) Change to basal bolus regimen
b) Stop oral agents and start basal insulin
c) Stop metformin and continue sitagliptin?
d) Stop oral agents, start exenatide 5 mcg b.i.d.
Insulin Treatment in Non-ICU Setting

T2DM with BG > 140 mg/dl (7.7 mmol/l)

- NPO
- Uncertain oral intake
  - Basal insulin
    - Start at 0.2-0.25 U/Kg/day*
    - Correction doses with rapid acting insulin AC
    - Adjust basal as needed

- Adequate Oral intake
  - Basal Bolus
    - TDD: 0.4-0.5 U/Kg/day
      - 1/2 basal, 1/2 bolus
    - Adjust basal as needed

* Reduce TDD to 0.15 U/kg in patients ≥70 yrs and/or serum creatinine ≥ 2.0 mg/dL

ADA Standard of Care, Diabetes Care 2018
Umpierrez et al. Endocrine Society Guidelines. JCEM 2012
Basal Plus Correction vs. Basal Bolus

**Basal plus supplements**
- Starting glargine*: 0.25 U/kg
- Correction with glulisine for BG >140 mg/dl per scale

**Baseline Bolus Regimen**
- Starting TDD*: 0.5 U/kg
  - Glargine: 0.25 U/kg
  - Glulisine: 0.25 U/kg (AC)
  - Correction with glulisine for BG >140 mg/dl per scale

* Reduce TDD to 0.15 U/kg in patients ≥70 yrs and/or serum creatinine ≥ 2.0 mg/dL

* Reduce TDD to 0.3 U/kg in patients ≥70 yrs and/or serum creatinine ≥ 2.0 mg/dL

Basal-PLUS vs Basal Bolus: Medicine and Surgery Patients

**Medicine**

- Daily BG

**Surgery**

- Daily BG

**BG AC & HS**

Insulin Treatment in Non-ICU Setting

**T2DM with BG > 140 mg/dl (7.7 mmol/l)**

- NPO
  - Uncertain oral intake

- Basal insulin
  - Start at 0.2-0.25 U/Kg/day*
  - Correction doses with rapid acting insulin AC
  - Adjust basal as needed

- Basal Bolus
  - TDD: 0.4-0.5 U/Kg/day
  - ½ basal, ½ bolus
  - Adjust basal as needed

* Reduce TDD to 0.15 U/kg in patients ≥70 yrs and/or serum creatinine ≥ 2.0 mg/dL

ADA Standard of Care, Diabetes Care 2018
Umpierrez et al. Endocrine Society Guidelines. JCEM 2012
Use of Oral Agents for the Management of Non-ICU Patients With Type 2 Diabetes

Inpatient Management in non-ICU

Basal Bolus

What about Oral Agents?
Distribution of OAD use in hospitalized patients

- Basal or basal bolus: 72%
- OAD: 24%
- OAD + Basal: 4%

*Data includes patients exposed to OAD or basal insulin for ≥ 48hrs, or complete hospital stay (if <48hrs)

Pasqued & Umpierrez et al. ADA 2014
DPP-4 Therapy in Hospitalized Patients

- **Study type**: Multicenter, prospective, open-label randomized clinical trial
- **Patient Population**: Patients with T2D in general medicine and surgery services treated with oral agents or insulin at a TDD < 0.5 IU/kg/day
- **Treatment Groups**
  - Group 1. Sitagliptin once daily (n=30)
  - Group 2. Sitagliptin plus glargine insulin once daily (n=30)
  - Group 3. Basal bolus regimen with glargine once daily and lispro before meals (n=30)

*All groups received supplemental lispro for BG > 140 mg/dl before meals*

Mean Daily BG During Treatment

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

Sitagliptin Hospital Trial
Research Design and Methods

- **Study Type:** Multicenter, prospective, open-label randomized clinical trial
- **Patient Population:** Patients with T2DM admitted with BG between 140-400 mg/dL, treated with diet, OADs and insulin at TDD < 0.6 U/kg
- **Treatment Groups***
  - Group 1. Sitagliptin plus glargine once daily (n=140)
  - Group 2. Basal bolus regimen with glargine once daily and rapid-acting insulin before meals (n=140)

* Both groups received supplemental (correction) doses of rapid-acting insulin for BG > 140 mg/dL before meals

Sita-Hospital Trial: Mean Daily BG

Mean Daily BG (mg/dl)

- Sitagliptin + Basal
- Basal Bolus

Mean BG AC & HS (mg/dl)

- Sitagliptin + Basal
- Basal Bolus

Duration of treatment (days)

Blood glucose (mg/dL)

Breakfast, Lunch, Dinner, Bedtime

Blood glucose (mg/dL)

Data are mean ± SE

Pasquel et al. Lancet Diabetes & Endocrinol May (5), 2017
Linagliptin Inpatient Trial
A Randomized Controlled Trial on the Safety and Efficacy of Linagliptin Therapy in General Surgery Patients with T2D

- **Linagliptin**: 5 mg/day
- **Basal Bolus Regimen**:
  - Total daily insulin dose: 0.4 unit/kg/day for BG between 140-200 mg/dl and 0.5 unit/kg/day for BG between 201-400 mg/dl
  - Half of total daily dose (TDD) given as glargine once daily
  - Half of TDD given as lispro in three equal doses before meals

* Supplemental (correction) doses of rapid-acting insulin analog per sliding scale given as needed before meals for BG > 140 mg/dl or bedtime > 200 mg/dl

Vellanki et al. Diabetes Obes Metab. 2018 Nov 20. [Epub ahead of print]
## Lina Surgery Trial: Daily Glucose Levels

<table>
<thead>
<tr>
<th>Inpatient BG, days 2-10</th>
<th>Basal Bolus</th>
<th>Linagliptin</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients, mg/dL</td>
<td>160 ± 41</td>
<td>171 ± 46</td>
<td>0.04</td>
</tr>
<tr>
<td>Randomization BG &lt;200 mg/dL</td>
<td>156 ± 41</td>
<td>160 ± 41</td>
<td>0.43</td>
</tr>
<tr>
<td>Randomization BG ≥200 mg/dL</td>
<td>165 ± 40</td>
<td>196 ± 47</td>
<td>0.001</td>
</tr>
</tbody>
</table>

### Hypoglycemia

<table>
<thead>
<tr>
<th></th>
<th>Basal Bolus</th>
<th>Linagliptin</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG &lt;70 mg/dL, n (%)</td>
<td>14 (11)</td>
<td>2 (1.6)</td>
<td>0.001</td>
</tr>
<tr>
<td>BG &lt;40 mg/dL, n (%)</td>
<td>0 (0)</td>
<td>1 (0.8)</td>
<td>&gt;0.99</td>
</tr>
</tbody>
</table>

### Treatment failures, n (%)

- Basal Bolus: 10 (8.2)
- Linagliptin: 19 (15)

### Composite complications, n (%)

- Basal Bolus: 11 (9)
- Linagliptin: 14 (11)

Vellanki et al. Diabetes Obes Metab. 2018 Nov 20. [Epub ahead of print]
Saxagliptin in Non-Critically ill Hospitalized Patients with T2D and Mild Hyperglycemia

Mean Blood Glucose During Study

Mean A1c: 6.6%
Random BG: 158 mg/dl

N= 62

BMJ Diabetes Research & Care March 5 (1) e000394, 2017
Case #3: Diabetes and Corticosteroid Therapy

A 55-year-old female was admitted with COPD exacerbation with increasing shortness of breath, dyspnea and wheezing for 3 days. Physical exam revealed tachypnea and wheezing. The chest x-ray was consistent with COPD.

The patient has a 4-year history of T2D treated with metformin. The patient received bronchodilators and 40 mg of methylprednisolone. She is scheduled to receive prednisone 40 mg/daily for 5 days.

Laboratory results are as follows: HbA1c 7.6%,
BG prior to prednisone: 144 mg/dL,
BG the following day: 188 AM, 211 mg/dL at lunch
Case Presentation: Diabetes and Corticosteroid Therapy

A 55-year-old female was admitted with COPD exacerbation with increasing shortness of breath, dyspnea and wheezing for 3 days. Physical exam revealed tachypnea and wheezing. The chest x-ray was consistent with COPD.

The patient has a 4-year history of T2D treated with metformin. The patient received bronchodilators and 40 mg of methylprednisolone. She is scheduled to receive prednisone 40 mg/daily for 5 days.

Laboratory results are as follows: HbA1c 7.6%, BG prior to steroid 144 mg/dL, and BG the following morning 188 mg/dL.

What is the best treatment option to treat steroid-induced hyperglycemia?

a) Basal bolus regimen
b) Basal PM plus NPH insulin in AM
c) GLP1-RA
d) DPP4-I plus basal insulin
Frequency of hyperglycemia in patients receiving high dose steroids*

*≥Prednisone 20 mg or equivalent

Basal Bolus vs. Basal Bolus plus NPH in CFRD Patients with Steroid-Induced Hyperglycemia

NPH dose: 1 U for 1 mg methylprednisolone for the first 20 mg of steroid; 0.5 U for 1 mg of methylprednisolone for the next 20 mg; and 0.25 U for each subsequent mg of steroid.  
### NPH in combination with BBI (Glargine + Lispro) in Patients Treated with GC for acute exacerbation COPD

<table>
<thead>
<tr>
<th></th>
<th>BBI w NPH</th>
<th>BBI</th>
<th>p</th>
</tr>
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<tbody>
<tr>
<td>Day 2 Avg daily BG mg/dl</td>
<td>156± 46</td>
<td>173 ± 51</td>
<td>NS</td>
</tr>
<tr>
<td>Day 5 Avg daily BG mg/dl</td>
<td>137 ± 34</td>
<td>150 ± 48</td>
<td>NS</td>
</tr>
<tr>
<td># BG &lt; 50/mg/dl</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>% BG &gt; 180 mg/dl</td>
<td>29%</td>
<td>38%</td>
<td>NS</td>
</tr>
</tbody>
</table>

Dosing:
Prior to GC Rx: Glargine 0.2 units/kg/d  Lispro 0.2 units/kg/day in 3 divided doses
With GC Rx: NPH or Lispro 0.1-0.4 units/kg for Prednisone doses 10-> 40 mg/dl

*Abdelnour S et al. ENDO 2012 Abstract MON-213*
Steroids and Diabetes: To Treat or Not?

- Not all patients require intensive insulin therapy
- BG < 180 mg/dl:
  - Short courses of GC + minimal hyperglycemia = *may not warrant intervention*.
  - Correction (SSI) insulin usually works in non-DM patients
  - Minimize duration and steroid dosage
- BG > 180 mg/dl:
  - Higher dose steroids + longer periods = start basal insulin or NPH
Suggested Approach for Treatment of Hyperglycemia in Patients Receiving High dose Glucocorticoid Therapy

<table>
<thead>
<tr>
<th>Prednisone (mg/day)</th>
<th>NPH (units/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 40</td>
<td>0.4</td>
</tr>
<tr>
<td>30</td>
<td>0.3</td>
</tr>
<tr>
<td>20</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Administered in AM at time of prednisone administration

Glargine or detemir may be preferred if dexamethasone used or BID Prednisone

*Clore JN, Thurber-Hay L. Endocrine Practice 15:469 2009*
Steroid-Induced Hyperglycemia: Non-DM patient

**Oral Steroids**

BG > 180 mg/dl > 2

NPH insulin 0.1-0.2 U/kg/day
- Basal (glargine/detemir)
  - Start at 0.1-0.2 U/Kg/day
  - Correction doses with rapid acting insulin AC
  - Adjust basal as needed

If persistent BG > 180 mg/dl
- Combine NPH AM + Basal PM
- Basal 0.2 U/kg + NPH 0.1 U/kg
OR
- Basal Bolus
  - TDD: 0.4-0.5 U/Kg/day
  - ½ basal, ½ bolus

Adjust NPH or basal insulin daily
- Increase by 10% if BG 140-200 mg/dl; by 20% if BG 200-300 mg/dl,
  and by 30% if BG >300 mg/dl

Emory University Protocol, 2017
Steroid-Induced Hyperglycemia:
DM patient

Oral Steroids
BG > 180 mg/dl X >2

NPH insulin 0.2- 0.4 U/kg/day
- Basal (Glargine/detemir)
- Start at 0.2-0.4 U/Kg/day
- Correction doses with rapid acting insulin AC
- Adjust basal as needed

If persistent BG > 180 mg/dl
- Combine NPH AM + Basal PM
- Basal 0.2 U/kg + NPH 0.1 U/kg
OR
Basal Bolus
- TDD: 0.4-0.6 U/Kg/day
- ½ basal, ½ bolus

Adjust NPH or basal insulin daily
Increase by 20% if BG 140-200 mg/dl; by 30% if BG 200-300 mg/dl,
and by 40% if BG >300 mg/dl

Umpierrez et al. Emory University Protocol. Unpublished
GLP-1 RA and glucocorticoid-induced glucose intolerance

van Raalte DH et al. Diabetes Care. 34(2):412 2011
A 60-year-old female was admitted with a 14-year history of T2D with poor oral intake after abdominal aortic aneurysm repair surgery. She is to be started on nutrition support with enteral feedings with a goal of 1,500 calories/day. She is currently treated with regular insulin per sliding scale.

Laboratory results are as follows:

- HbA1c 8.2%
- Mean fasting BG 198 mg/dL
- BG AC: 144-220 mg/dL

**Case #4: Diabetes and Nutrition Support**

What is the best treatment option to treat hyperglycemia during enteral feeding?

- a) Basal or basal-bolus regimen
- b) Basal PM plus NPH insulin in AM
- c) Premixed 70/30 b.i.d. or t.i.d
- d) NPH insulin t.i.d or q.i.d
Enteral Nutrition/Tube feeding

- Continuous
  - Infusing over 24 hrs
- Bolus
  - Mimics meals
- Nocturnal
  - Infusion at night: typically 12 hr infusion
  - Can be NPO or eating during day
  - Usually transitioning stage
Fifty inpatients with > 2 BG >130mg/dl during ENT

- Randomized to the SSRI (n: 25)
- Glargine (n: 25)

- SSRI was administered every 4–6 h (POCT)
- Goal BG = 100-180 mg/dL
Insulin Therapy in Hospitalized Patients During Enteral Nutrition

SSRI Q 4-6 h
BG > 180 mg/dl

SSRI + NPH b.i.d
50% Basal
50% Prandial

Glargine 10 U/d
+ SSRI
BG > 180 mg/dl

Intensified Basal Bolus Regimen
Results

- No differences in mean BG concentration
- Most patients with DM and non-DM with BG > 180 mg/dl required NPH insulin

Insulin dose:
- DM, TDD = 0.61 ± 0.28 U/kg/day
- No DM, TDD = 0.39 ± 0.28 U/kg/day

Diabetes Care 32:594–596, 2009
Hyperglycemia during Enteral Nutrition

BG > 140 mg/dl ➔ Change to special diabetes formulas

BG > 180 mg/dl ➔ 2

No-Diabetes

- Basal at 0.1-0.2 U/Kg/day
- NPH insulin 0.1 U/kg/b.i.d
- Correction with regular or rapid-acting Q4-6 hr
- Adjust basal as needed

Adjust NPH or basal insulin daily

Diabetes

Basal Plus
- Basal plus: 0.2 U/kg/day
- Basal bolus:
  - TDD: 0.4-0.5 U/Kg/day
  - ½ basal Q/D
  - ½ TDD as rapid ins Q4-6 h
- NPH insulin 0.1-0.2 U/kg/b.i.d
- NPH insulin 0.1 U/kg/t.i.d
- Regular or rapid-acting Q4-6 hr

Emory University Protocol
Basal bolus vs 70/30 BID/TID

Hsia, Nutr Clin Pract. 2011;26:714-717
Management of Patients With Diabetes After Hospital Discharge

What Regimen Should We Use at Hospital Discharge?
Recommendations for Managing Patients With Diabetes After Hospital Discharge

Use admission A1C to adjust therapy at discharge

- **ADD basal or REPLACE with basal/bolus**: 10%
- **ADD basal insulin therapy**: 9%
- **Adjust original therapy, ADD another agent or basal insulin**: 8%
- **Return to original therapy**: 7%

Umpierrez G et al, J Clin Endocrinol Metabol, 2012
Discharge Insulin Algorithm

Discharge Treatment

- **A1C < 7%**
  - Re-start outpatient treatment (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.
  - Re-start oral agents and D/C on glargine once daily at 80% of hospital dose

Hospital Discharge Algorithm Based on Admission HbA1C for the Management of Patients with T2DM