Inpatient Hyperglycemia: A case study that sounds all too familiar

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Tuesday Morning Conference
March 16, 2010
Objectives:

• Case presentation

• Prevalence and impact

• Current guidelines

• Treatment strategies and common pitfalls

• Revisit of case presentation
Case Presentation:

- 42 y/o WF w/ cc of dysuria & back pain
  - Dx=pyelonephritis/ARF
  - PMH: “diet controlled” DM
  - Admit glucose = 290 mg/dl
Case Presentation:

• **Admit Orders**
  – Glargine/Lispro order set
  – Insulin “sensitive”
  – POC AC/HS checks

• **Hospital Day #1**
  – POC values 195 to 365 mg/dl
  – Changed to insulin “resistant”
  – Inpatient Diabetic Education ordered
Case Presentation:

- **Hospital Day #2**
  - POC ranges 210 to 265 mg/dl
    - Rx *glargine 5 units* daily
  - Received Diabetic Education
Case Presentation:

- Hospital Day #3
  - POC ranges 220 to 225mg/dl
  - A1c pending
  - Discharged
Sound familiar?
Inpatient Hyperglycemia: Definitions

- Medical History of Diabetes

- Unrecognized Diabetes
  - FBG >/- 126 mg/dl or RBG > 200mg/dl

- Hospital-related Hyperglycemia
  - FBG >/- 126 mg/dl or RBG >200mg/dl that normalizes after discharge

Inpatient Hyperglycemia: What causes this?

- Diabetes
  - DM 1 & 2; diagnosed vs undiagnosed
- Iatrogenic
  - Glucocorticoids, TPN, etc
- Stress-hyperglycemia
Inpatient Hyperglycemia: Prevalence

- Prevalence
  - 7.8% of population has DM (23.6 million)
  - 12.4-38% of all hospitalized adults
  - Estimated ~25% at UCH

Prevalence by Age Group

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.6%</td>
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<tr>
<td></td>
<td>10.8%</td>
</tr>
<tr>
<td></td>
<td>23.1%</td>
</tr>
</tbody>
</table>

Inpatient Hyperglycemia: 
Associated Costs

• Associated Costs
  – Total: $174 billion
    ($116 billion-direct)
    • Hospital-related costs
      ~44%
  – Expenditures 2.3x
    greater

Atlanta, GA: U.S. Dept of Health & Human Services, CDC. 2008

Inpatient Hyperglycemia:  
*Current Treatment Goal Guidelines*

- Critically ill **surgical** pts
  - Close to 110mg/dl, generally < 140mg/dl

- Critically ill **nonsurgical** pts
  - <140mg/dl

- Non-critically ill pts
  - Fasting < 126mg/dl
  - Random <180-200mg/dl

**NICE-SUGAR:**

- **Conventional Glucose Control**
  - Target: < 180 mg/dl
  - Mean: 144 +/- 23 mg/dl
  - Death: 24.9%

- **Intensive Glucose Control**
  - Target: 81-108 mg/dl
  - Mean: 115 +/- 18 mg/dl
  - Death: 27.5%
ADA & AACE Joint Statement:

• NICE-SUGAR
  – “….should NOT lead to an abandonment of the concept of good glucose management in the hospital setting.”
  – “..compared to a control group whose glucose control was good (average glucose 144 mg/dl).”
  – “….reasonable for clinicians to treat critical care patients with the less intensive, yet good-glucose control strategies used in the conventional arm…..”
How are we doing at UCH?

POC BG Values 2009
7th Medicine INMD

- May-Jun 09 Mean: BG 167
- Jul-Sept 09 Mean: BG 170

- ≥ 180 mg/dL: 1%
- 71-179 mg/dL: 63%
- 1% 3%
- 61% 61%
- 0% 0%
- 30% 50%
- 40% 40%
- 50% 50%
- 60% 60%
- 70% 70%
- 80% 80%
- 90% 90%
- 100% 100%

Data Source: Care Manager The Diabetes Program
How are we doing at UCH?

How are we doing at UCH?

POC BG Values 2008/2009
12th Medicine (MEDU)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Mean BG (mg/dL)</th>
<th>≥ 180 mg/dL</th>
<th>71-179 mg/dL</th>
<th>≤ 70 mg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul-Sept 08</td>
<td>154</td>
<td>2%</td>
<td>31%</td>
<td>72%</td>
</tr>
<tr>
<td>Oct-Dec 08</td>
<td>161</td>
<td>4%</td>
<td>66%</td>
<td>66%</td>
</tr>
<tr>
<td>Jan-Mar 09</td>
<td>160</td>
<td>3%</td>
<td>67%</td>
<td>67%</td>
</tr>
<tr>
<td>Apr-Jun 09</td>
<td>165</td>
<td>5%</td>
<td>61%</td>
<td>61%</td>
</tr>
<tr>
<td>Jul-Sept 09</td>
<td>161</td>
<td>3%</td>
<td>65%</td>
<td>65%</td>
</tr>
</tbody>
</table>

Data Source: Care Manager, The Diabetes Program
How are we doing at UCH?

POC BG Values 2008/2009
6th Medicine (MDSS)

<table>
<thead>
<tr>
<th>Month</th>
<th>08 Mean</th>
<th>09 Mean</th>
<th>09 Mean</th>
<th>09 Mean</th>
<th>09 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul-Sept</td>
<td>171</td>
<td>158</td>
<td>164</td>
<td>166</td>
<td>172</td>
</tr>
</tbody>
</table>

- ≥ 180 mg/dL: 2%, 3%, 4%, 3%, 2%
- 71-179 mg/dL: 35%, 71, 3%, 33%, 33%, 63%
- ≤ 70 mg/dL: 0%, 10%, 20%, 30%, 40%, 50%
How are we doing?

UCH vs Nationally

• UCH Trends
  – Hyperglycemia: \(~1/3\text{rd}\) of all POC values
  – Euglycemia: \(~2/3\text{rds}\) of all POC values
  – Hypoglycemia: \(~1-3\%\) of all POC values

• National Trends
  – Hyperglycemia: 31\% of all POC values, 31\% of pts
  – Euglycemia: \(~2/3\text{rds}\) of all POC values
  – Hypoglycemia: 1.2\% of all POC values, 11\% of pts

Inpatient Hyperglycemia:

Current Treatment Guidelines

- Critically ill surgical pts
  - IV insulin protocols

- Critically ill nonsurgical pts
  - IV insulin protocols

- Non-critically ill pts
  - Insulin preferred drug of choice
  - ISS not recommended as monotherapy

Physiological Insulin: Components

• Basal:
  – Targets *fasting* hyperglycemia

• Nutritional:
  – Targets IV dextrose, TPN, enteral feeds, nutritional supplements, or meals (prandial)

• Correction:
  – “supplemental” insulin for hyperglycemia
Inpatient Hyperglycemia: Current Treatment Guidelines

- **Diabetes Dx**
  - Basal/Bolus + correction dose insulin

- **Nondiabetic Hyperglycemia**
  - Glucose monitoring
  - Initially correction insulin
  - Transition to basal/bolus + correction w/ persistent hyperglycemia
  - Documented in D/C summary w/ appropriate f/u w/ testing

- **Inpatient Hyperglycemia**
  - A1c
  - DMSE “survival skills” education
  - F/u plan clearly documented

Insulin Requirements In Health and Illness:

- Healthy
- Sick/Eating
- Sick/NPO

- Correction
- Nutritional
- Prandial
- Basal
RABBIT 2 Trial:
Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients with Type 2 Diabetes

- Prospective, multicenter, randomized trial
- **Insulin-naive** type 2 diabetic pts on general medicine
- Compared *basal-bolus* vs. *SSI*
- **Primary end point:** mean daily blood gluoses
- **Secondary outcomes:** # hypoglycemic events, # events severe hyperglycemia, LOS, & mortality rate

*Umpierrez et al. Diabetes Care 30(9): 2181-2186, 2007.*
RABBIT 2 Trial

- Basal-bolus

**Total Daily Dose** = 0.4 or 0.5 u/kg \times \text{pt’s wt (kg)}

\text{Basal:bolus=50:50}

e.g. \text{Wt=70kg}

**TDD=0.4u/kg \times 70kg = 28\ units**

\text{Basal dose=14\ units}
\text{Bolus dose=14\ units (\sim 5\ units AC)}

## RABBIT 2 Trial

<table>
<thead>
<tr>
<th></th>
<th>Basal-bolus</th>
<th>SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TDD</strong></td>
<td>22+/-2 (basal)</td>
<td>12.5+/-2*</td>
</tr>
<tr>
<td></td>
<td>20+/-1 (bolus)</td>
<td></td>
</tr>
<tr>
<td><strong>Goal Mean Glc</strong></td>
<td>66%</td>
<td>38%*</td>
</tr>
<tr>
<td><strong>Mean Glc</strong></td>
<td>166+/-32</td>
<td>193+/-54*</td>
</tr>
<tr>
<td></td>
<td>147+/-36</td>
<td>165+/-41*</td>
</tr>
<tr>
<td></td>
<td>164+/-35</td>
<td>188+/-45*</td>
</tr>
<tr>
<td><strong>Hypoglycemia</strong></td>
<td>3%(0.4%)</td>
<td>3%(0.2%)</td>
</tr>
<tr>
<td><strong>Hyperglycemia</strong></td>
<td>0%</td>
<td>14%*</td>
</tr>
</tbody>
</table>

Glycemic control rapidly improved after switching to basal-bolus regimen after persistent severe hyperglycemia despite increasing doses of RISS.

• RABBIT 2 SURGERY
  – Basal-bolus in surgical pts resulted in improved glycemic control vs SSRI
  – Lower rates of ARF & nonwound infections (UTI, PNA, bacteremia)
  – Safe; no sign differences in mild or severe hypoglycemia vs SSRI
**UCH SQ Insulin Order Set**

*Glargine & Lispro*

**Insulin Sensitive**

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>NPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-124</td>
<td>3 units</td>
<td>No Insulin</td>
</tr>
<tr>
<td>125-149</td>
<td>3 units</td>
<td>No Insulin</td>
</tr>
<tr>
<td>150-199</td>
<td>4 units</td>
<td>1 unit</td>
</tr>
<tr>
<td>200-249</td>
<td>5 units</td>
<td>2 units</td>
</tr>
<tr>
<td>250-299</td>
<td>6 units</td>
<td>3 units</td>
</tr>
<tr>
<td>300-349</td>
<td>7 units</td>
<td>4 units</td>
</tr>
<tr>
<td>350-399</td>
<td>8 units</td>
<td>5 units</td>
</tr>
<tr>
<td>&gt;/- 400</td>
<td>Call MD</td>
<td>Call MD</td>
</tr>
</tbody>
</table>

- **Teaching Points**
  - Not only “SSI”
  - Prandial insulin + correction factor
**UCH SQ Insulin Order Set**

*Glargine & Lispro*

**Insulin Resistant**

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>PO Units</th>
<th>NPO Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-124</td>
<td>6 units</td>
<td>No Insulin</td>
</tr>
<tr>
<td>125-149</td>
<td>7 units</td>
<td>1 unit</td>
</tr>
<tr>
<td>150-199</td>
<td>8 units</td>
<td>2 units</td>
</tr>
<tr>
<td>200-249</td>
<td>10 units</td>
<td>4 units</td>
</tr>
<tr>
<td>250-299</td>
<td>12 units</td>
<td>6 units</td>
</tr>
<tr>
<td>300-349</td>
<td>14 units</td>
<td>8 units</td>
</tr>
<tr>
<td>350-399</td>
<td>16 units</td>
<td>10 units</td>
</tr>
<tr>
<td>&gt;/- 400</td>
<td>Call MD</td>
<td>Call MD</td>
</tr>
</tbody>
</table>

*Based on 6 units prandial insulin + correction factor*
UCH SQ Insulin Order Set

*Glargine & Lispro*

**Customized**

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>NPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-124</td>
<td>_ units</td>
<td>_ units</td>
</tr>
<tr>
<td>125-149</td>
<td>_ units</td>
<td>_ units</td>
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<td>150-199</td>
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<td>200-249</td>
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<td>250-299</td>
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<td>300-349</td>
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<td>_ units</td>
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<tr>
<td>350-399</td>
<td>_ units</td>
<td>_ units</td>
</tr>
<tr>
<td>&gt;/ or 400</td>
<td>Call MD</td>
<td>Call MD</td>
</tr>
</tbody>
</table>

- Make your own!!!!
Treatment Practices

**UCH vs Nationally**

**UCH**
- Insulin order sets
  - Initiated if unknown PMH when POC > 170mg/dl
  - Adjusting insulin q2-3 days, 40% of pts had adjustments
  - < 25% use of basal insulin at admission
  - ~50% basal use during hospitalization, 3-4d lag time
  - < 20-40% of interns knew pt’s POC or lispro doses

**Nationally**
- 90% use of POE ISS
- 43% of pts w/ basal during hospitalization
- Only 35% of pts w/ hyper/hypoglycemia had adjustments made to insulin orders

Austin, M. Glycemic Control and Clinical Inertia in the Inpatient Setting. QI Project, 9/08.
Don’t Fall for These Common Treatment Pitfalls

• Basal/bolus + correction
  – Using order set as “ISS” ➔ Bolus + correction factor
  – Not using basal ➔ Rabbit 2 trial
  – Converting “sensitive” to “resistant” for persistent hyperglycemia ➔ Add Basal
  – Uptitrating basal w/o bolus ➔ Basal:Bolus=50:50
  – Lispro standing order + order set ➔ Customize
Don’t Fall for These Common Treatment Pitfalls

- Holding basal when NPO ➔ 50%-100% OK
- Adjusting insulin w/o discussing w/ nurse ➔ Team Work!
Inpatient Hyperglycemia: Transitions

• D/c summaries for 36% of hyperglycemic pts did NOT mention dx of DM or hyperglycemia despite 1/3rd having documentation in progress note

• 7 weeks average time for post-hosp DM visit

• 16% of DM pts w/o f/u visit


Transitions Discharge Planning:

- Starts at admission
  - Prior Dx of DM/Hyperglycemia
  - Management of DM
  - Prior glycemic control (A1c)
  - Resource availability
Outpatient DM Rx Costs: Oral Agents

- Wal-Mart:
  - Chlorpropamide
  - Glimepiride
  - Glipizide
  - Glyburide
  - Metformin

- Walgreen's:
  - Glimepiride
  - Glipizide
  - Glyburide
  - Glyburide/Metformin
  - Metformin

$4 RX
Outpatient DM Rx Costs:  

*Insulin Therapy*

- **Basal**
  - Glargine $101.75
  - NPH $48.15

- **Bolus**
  - Lispro $101.75
  - Regular $48.15

Glargine & Lispro ARE covered under CICP!
“Survival Skills” Education

1. Level of understanding
2. Home BG goals & monitoring
3. S/Sx of hyper/hypoglycemia, prevention & treatment
4. Outpt MD
5. Eating patterns
6. Rx management
7. Sick-day management
8. Needle/syringe disposal
Transitions
Discharge Planning:

- PCP F/u w/in 1 month
- Communication w/ PCP
What the heck is going on?

- **Clinical Inertia**
  - “not initiating or intensifying therapy when doing so is indicated”.

Main Causes
- 1). Overestimate of care provided
- 2). Use of “soft” reasons to avoid intensification
- 3). Lack of education, training and practice organization aimed at achieving specific goals

Turning Clinical Inertia into Momentum
Inpatient Hyperglycemia:
Standardized Patient Approach

- **Identify reasons for hyperglycemia**
  - Dx of DM, stress-induced, iatrogenic

- **Identify clinical setting**
  - SICU, MICU, wards, stroke, etc

- **Identify treatment goals for clinical setting**

- **Implement treatment plan as a team approach** *(MD, RN, CNA, RD, patient, etc)*

- **Outline transition plan clearly for providers and patient**
Case Presentation Revisted: 

Let's apply what we’ve learned

• Admission
  – Primary Dx=Pyelonephritis
  – Secondary Dx=Hyperglycemia/ARF

Why does B.S have hyperglycemia?

Presume underlying insulin resistance + stress hyperglycemia.
Case Presentation Revisted: 

*Lets apply what we’ve learned*

- **Identify clinical setting**
  - B.S. admitted to general medicine, “noncritically ill”

- **Identify treatment goals for clinical setting**
  - Non-critically ill pts
    - Fasting < 126mg/dl
    - Random <180-200mg/dl

- **Implement treatment plan as a team approach** *(MD, RN, CNA, RD, patient, etc)*
  - Basal/bolus + correction factor
  - Obtain A1c
  - “survival skills” diabetic education
  - Actively treat DM

- **Outline transition plan clearly for providers and patient**
  - Clearly document in D/C summary
  - Outpatient f/u plan
  - Determine D/C Rx
Special Thanks!!!!

- Bridget Everhart
- Carolee Whitehill
Questions?