The Diabetic Surgical Patient

Pre- and Peri-Operative Recommendations

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Disclosures

• No financial conflicts of interest
Overarching Goals

- Importance of glycemic control in the surgical patient
- How to risk stratify your diabetic surgical pt.
- Pre-Op, Intra-Op, and Post-Op glycemic control strategies
- Transitioning your patient for discharge
Lecture Outline

Managing the Diabetic Surgical Patient

- Hyperglycemia in the Surgical Patient
- Pre-Operative Management
- Intraoperative Management
- Post-Operative Management
- Transitioning the Patient to Home
Managing the Diabetic Surgical Patient

- Hyperglycemia in the Surgical Patient
- Pre-Operative Management
- Intraoperative Management
- Post-Operative Management
- Transitioning the Patient to Home
Diabetics undergoing Surgery

Multiple Roads to Hyperglycemia

- DM
- Obesity
- Sepsis

Baseline Insulin Resistance

Hyperglycemia

- Stress of surgery
- Sympathetic surge
- Stress hormones

Neuro-endocrine Stress Response

Intra-Op Management

- Volatile Agents
- Dextrose Fluids
- Steroids

- Adrenergic Agonists
- Hypothermia

Adapted from Barash, Clinical Anesthesia, Lippincott Williams & Williams, NY, NY ©2013
Perioperative Hyperglycemia

The Sequelae to Consider…

• Increases surgical site infections
• Increases perioperative morbidity & mortality
• Increases in-hospital Pulmonary Embolus
• Increases length of stay
## Complications of Hyperglycemia

### Hyperglycemia & Sequelae

<table>
<thead>
<tr>
<th>Author</th>
<th>Trial</th>
<th>Marker</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gustafsson, 2009</td>
<td>Prospective</td>
<td>HgA1c &gt; 6.0%</td>
<td>Incr: PNA, UTI, Ileus</td>
</tr>
<tr>
<td>Dronge, 2006</td>
<td>Retrospective</td>
<td>HgA1c &gt; 7.0%</td>
<td>Incr: PNA, SSI, UTI, sepsis</td>
</tr>
<tr>
<td>Han, 2013</td>
<td>Retrospective</td>
<td>HgA1c &gt; 8%</td>
<td>Incr: SSI in TKA pts</td>
</tr>
<tr>
<td>Sato, 2010</td>
<td>Retrospective</td>
<td>HgA1c &gt; 6.5%</td>
<td>Incr: PNA, UTI, SSI after elective cardiac surgery</td>
</tr>
<tr>
<td>Trick, 2000</td>
<td>Retrospective</td>
<td>BG &gt; 200mg/dL</td>
<td>Incr: Sternal wound infxn in CABG pts</td>
</tr>
</tbody>
</table>

**CABG:** Coronary Artery Bypass Graft  
**PNA:** Pneumonia  
**UTI:** Urinary Tract Infection  
**SSI:** Surgical Site Infection
Pathophysiology for SSI

Multiple Sources for Hyperglycemia in Surgery

Glycemic Control & SSIs

The Animal Data shows Reduction in SSIs

Cause Diabetes

LT Insulin

ST Insulin

SSI

Bacterial Measurement

Glycemic Control & SSIs

ST Insulin Rx may be sufficient to reduce SSIs

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The Management Roadmap

Surgery Scheduled

DOS

Pre-Op

Medication Instructions

A1C

Medication Adjustment

CII

Intra-Op

BBI

Post-Op

Home Regimen

Discharge

Adjusted Insulin

Basal

DOS: Day of Surgery
CII: Continuous Insulin Infusion
BBI: Basal + Bolus Insulin Regimen

UCLA Health
Should I Delay My Patient’s Surgery?

Consider A1C, Urgency, and Control Requirements

• A1C < 7% is associated with decreased perioperative infection rates
• Unclear evidence for overt case cancellation
• Delay of surgery:
  – **Elective Surgery**: Delay to improve glycemic control
  – **Semi-Urgent**: Short delay to attempt improvement in glycemic control
  – **Urgent**: Do not delay → control glucose on DOS
Pre-Operative Hyperglycemia

HgA1c Assists with Risk Stratification

- Pre-Op HgA1c > 6%: Risk Stratifies post-op hyperglycemia risk

**Pre-Operative Hyperglycemia**

### Day of Surgery Medication Adjustments...

#### DM Type I
- Maintain basal insulin dose
  - 50% of NPH insulin
- Anticipate CII
- **Insulin Pump:**
  - Cont. basal infusion or...
  - DC pump → administer SQ basal insulin

#### DM Type II
- Hold oral hypoglycemic and non-insulin injectables on DOS
- Basal + Prandial bolus insulin
- **Insulin:**
  - Maintain basal insulin (70-100%)
  - Reduce NPH (50%)

*Umpierrez et al. J. Clin Endocrinol Metab, 97(1), 2016. pg. 28-29*
Managing the Diabetic Surgical Patient

- Hyperglycemia in the Surgical Patient
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Pathophysiology

Anesthesia Induction & Hyperglycemia

- Abrupt decrease in insulin secretion
- Volatiles suppress insulin pulse mass

Intraoperative Management

The Devil is in the Details

• Lack of Data for Non-Cardiac Surgery
  – 5 small RTCs for intraoperative control
  – 1 meta-analysis with 5 small RTCs (Hua, 2012)
  – Intervention groups had intensive targets (BG 80-110)

• Analyses show mixed results in cardiac surgery population

• Difficult to extrapolate to non-cardiac patient population
The Management Roadmap

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Basal

DOS: Day of Surgery
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## Intraoperative IIT Risks

**Increased Death, Stroke, & Hypoglycemia**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intensive Treatment Group (n = 185), n (%)</th>
<th>Conventional Treatment Group (n = 186), n (%)</th>
<th>Relative Risk or Odds Ratio (95% CI)†</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Any event</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>82 (44)</td>
<td>86 (46)</td>
<td>1.0 (0.8 to 1.2)</td>
<td>0.71</td>
</tr>
<tr>
<td>Postdischarge (up to 30 days after surgery)</td>
<td>78 (42)</td>
<td>82 (44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 (4)</td>
<td>9 (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Death</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>4 (2)</td>
<td>0 (0)</td>
<td>∞ (0.9 to ∞)</td>
<td>0.061</td>
</tr>
<tr>
<td>Postdischarge (up to 30 days after surgery)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stroke</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>8 (4)</td>
<td>1 (1)</td>
<td>8.0 (1.0 to 63.7)</td>
<td>0.020</td>
</tr>
<tr>
<td>Postdischarge (up to 30 days after surgery)</td>
<td>7 (4)</td>
<td>1 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 (1)</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Deep sternal infection</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>6 (3)</td>
<td>7 (4)</td>
<td>0.9 (0.3 to 2.5)</td>
<td>0.79</td>
</tr>
<tr>
<td>Postdischarge (up to 30 days after surgery)</td>
<td>3 (2)</td>
<td>1 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (2)</td>
<td>6 (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cardiac arrest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>∞ (0.1 to ∞)</td>
<td>0.50</td>
</tr>
<tr>
<td>Postdischarge (up to 30 days after surgery)</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intraoperative IIT Benefits

Reduced infections without increase mortality

Table 1. Characteristics of Studies Included in This Meta-Analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>Sample Size (IIT/CIT)</th>
<th>Diabetes Mellitus (IIT/CIT)</th>
<th>Mean Age (y)</th>
<th>Target Blood Glucose Level (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chan et al\textsuperscript{14}</td>
<td>2009</td>
<td>Portugal</td>
<td>47/51</td>
<td>10/22</td>
<td>57.5</td>
<td>IIT 80-130, CIT 160-200</td>
</tr>
<tr>
<td>Albacker et al\textsuperscript{15}</td>
<td>2008</td>
<td>Canada</td>
<td>27/25</td>
<td>11/10</td>
<td>64.5</td>
<td>IIT 70-110, CIT &lt;180</td>
</tr>
<tr>
<td>Albacker et al\textsuperscript{16}</td>
<td>2007</td>
<td>Canada</td>
<td>22/22</td>
<td>5/9</td>
<td>62</td>
<td>IIT 70-110, CIT &lt;180</td>
</tr>
<tr>
<td>Gandhi et al\textsuperscript{17}</td>
<td>2007</td>
<td>USA</td>
<td>185/186</td>
<td>37/36</td>
<td>63</td>
<td>IIT 80-100, CIT &lt;200</td>
</tr>
<tr>
<td>Lazar et al\textsuperscript{18}</td>
<td>2004</td>
<td>USA</td>
<td>72/69</td>
<td>72/69</td>
<td>63.6</td>
<td>IIT 126-200, CIT &lt;250</td>
</tr>
</tbody>
</table>

Abbreviations: CIT, conventional insulin therapy; IIT, intensive insulin therapy; USA, United States of America.

A Reason for Arterial Blood Sampling

Problems with Capillary Accucheck Testing

Kanji et al. Critical Care Medicine 33(12), 2005
<table>
<thead>
<tr>
<th>Lecture Outline</th>
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<td>Transitioning the Patient to Home</td>
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The Management Roadmap

Surgery Scheduled

DOS

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A1C

Medication Adjustment

Medication Instructions
Post-Operative Hyperglycemia

Basal + Bolus suggested over sliding scale

Basal-Bolus Method (BBI)

- BG 140-400 mg/dL
- TDD: 0.5U/kg
  - Half as Glargine
  - Half divided btw meals (Prandial Insulin)
Post-Operative Hyperglycemia

Basal + Bolus suggested over sliding scale

Adapted from Umpierrez et al. Diabetes Care Vol. 34, 2011
## Post-Operative Hyperglycemia

### Hypoglycemic Events are still present

<table>
<thead>
<tr>
<th>Variable</th>
<th>All</th>
<th>SSI</th>
<th>Basal-bolus insulin</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>211</td>
<td>107</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>Number of BG tests</td>
<td>3,778</td>
<td>1,826</td>
<td>1,952</td>
<td></td>
</tr>
<tr>
<td>BG &lt;40 mg/dL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients (%)</td>
<td>4 (3.8)</td>
<td>0 (0)</td>
<td>4 (3.8)</td>
<td>0.057</td>
</tr>
<tr>
<td>Number of events</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Number of readings (%)</td>
<td>0.10</td>
<td>0</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>BG &lt;60 mg/dL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients (%)</td>
<td>14 (6.6)</td>
<td>2 (1.9)</td>
<td>12 (11.5)</td>
<td>0.005</td>
</tr>
<tr>
<td>Number of events</td>
<td>17</td>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Number of readings (%)</td>
<td>0.45</td>
<td>0.11</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>BG &lt;70 mg/dL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients (%)</td>
<td>29 (0.8)</td>
<td>5 (4.7)</td>
<td>24 (23)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of events</td>
<td>44</td>
<td>6</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Number of readings (%)</td>
<td>1.16</td>
<td>0.33</td>
<td>1.95</td>
<td></td>
</tr>
</tbody>
</table>

Umpierrez et al. Diabetes Care Vol. 34, 2011
Basal + Bolus Dosing

Starting Your Post-Op Regimen

**TDD Calculation**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>TDD (Units/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥ 70 or GFR ≤ 60mL/min</td>
<td>0.2-0.3</td>
</tr>
<tr>
<td>BG 140-200 mg/dL</td>
<td>0.4</td>
</tr>
<tr>
<td>BG 201-400 mg/dL</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Correction Scale**

<table>
<thead>
<tr>
<th>BG (mg/dL)</th>
<th>Sensitive</th>
<th>Usual</th>
<th>Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>141-180</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>181-220</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>221-260</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>261-300</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>301-350</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>351-400</td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>&gt;400</td>
<td>14</td>
<td>16</td>
<td>18</td>
</tr>
</tbody>
</table>

Adapted from Umpierrez et al. J. Clin Endocrinol Metab, 97(1), 2016.
Glucose Control in the Critically Ill
ICUs Now Favoring More Lenient Thresholds

**Intensive Insulin Therapy (IIT)**
- BG ~ 80-120
- Lower Surgical Site Infections
- More hypoglycemic Events
- Higher stroke risk
- Increased cardiac events

**Conventional Therapy (CT)**
- BG ~ 140-180
- Lower Mortality
- Less hypoglycemic Events
Hypermeglycemia Management

IIT from the ICU Literature: A Swinging Saga

2009: Back to Conventional therapy

- All-cause mortality INCREASED with IIT
- Severe hypoglycemia posited to cause major negative events
- No differences between SICU & MICU patients

Finfer al., NEJM, 360(13), 2009.
The Management Roadmap

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Transition Towards Discharge

- Intra-Op
- Post-Op
- Discharge

CII

BBI

Home Regimen

Adjusted Insulin

Basal

1-2hrs prior to D/C of CII

Initiate 24hrs prior to discharge
THANK YOU
NKAMDAR@MEDNET.UCLA.EDU