Glucose Management in the ICU: The Role of the Pharmacist

James Gilmore PharmD, BCPS
Senior Pharmacist - Surgical Intensive Care Unit
Brigham and Women’s Hospital
Boston, MA

Objectives
- Evaluate primary literature regarding glycemic targets in the ICU
- Discuss controversial issues of glucose management in the ICU
- Analyze medications therapy options for glucose management in a critically ill patient

Questions without a clear answer
- What is the best method to maximize efficacy and minimize toxicity?
- What should the goal be?
  - Is it different depending on population
  - Does PMH of ± DM matter?
- What is the safest way?

Inpatient Hyperglycemia
- Inpatient hyperglycemia is a common problem
- Hyperglycemia in a hospital setting was historically only treated only at very high levels
- Evidence suggests a close correlation between hyperglycemia and clinical outcomes

Surgery and Hyperglycemia: Overview
- Patients with diabetes comprise 29% of surgical population
- Associated with:
  - Longer stay
  - Greater infection rate
  - Higher operative mortality
  - Worse long-term prognosis

Is Hyperglycemia Common in Critically ill Patients?

Factors Effecting Glucose Control

- Increased counter-regulatory hormones
  - Catecholamines
  - Cortisol
  - Somatotropin (GH)
  - Glucagon
- Medications
  - Steroids
  - Antipsychotics
- Acidosis and insulin sensitivity
- Caloric intake

Patient Case

TY is admitted to the Surgical Intensive Care Unit following an emergent thoracotomy requiring mechanical ventilation and vasopressor support. BG values are as follows: 1800: 231 mg/dL, 0000: 219, 0600: 267. In accordance with multidisciplinary guideline recommendations, which of the following should interventions be initiated to manage TY’s BG values?

A. Initiate metformin 500mg PO twice daily
B. Initiate a weight based subcutaneous insulin regimen consisting of Basal, Prandial and Correctional insulin
C. Initiate intravenous insulin infusion according to institutional protocol
D. Initiate a subcutaneous regular insulin via sliding scale every 6 hours

Glycemic Control in a Nutshell

- Hyperglycemia and hypoglycemia are bad
- **Inpatient** glucose management
  - Oral agents: AVOID
  - Insulin: Treatment of choice
  - Home regimens will change
- Protocol-driven care throughout institution is necessary to standardize treatment modalities
  - Insulin is still a high risk medication

Hyperglycemia and Mortality: Stamford Hospital Analysis

![Graph showing the relationship between mean glucose values and mortality rates](image)

Inpatient Transitions and the Management of Hyperglycemia

<table>
<thead>
<tr>
<th>Phase of Care</th>
<th>Modality for Glucose Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient</td>
<td>Oral Agents, SC insulin</td>
</tr>
<tr>
<td>Emergency Department</td>
<td>SC Insulin</td>
</tr>
<tr>
<td>Procedural Area</td>
<td>SC or IV Insulin</td>
</tr>
<tr>
<td>Intensive Care Unit</td>
<td>IV Insulin</td>
</tr>
<tr>
<td>Step-down/ general Ward</td>
<td>SC Insulin</td>
</tr>
<tr>
<td>Outpatient</td>
<td>Oral Agents, SC insulin</td>
</tr>
</tbody>
</table>

Hypoglycemia and Mortality: Australian Database Analysis

<table>
<thead>
<tr>
<th>Hypoglycemia</th>
<th>Incidence</th>
<th>Hospital Mortality (%)</th>
<th>Adjusted OR (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>92.9%</td>
<td>15.7%</td>
<td>1.0</td>
</tr>
<tr>
<td>&lt; 73 mg/dL</td>
<td>6.2%</td>
<td>29.5%</td>
<td>1.5 (1.3-1.6)</td>
</tr>
<tr>
<td>&lt; 40 mg/dL</td>
<td>0.9%</td>
<td>57.4%</td>
<td>2.6 (2.1-3.2)</td>
</tr>
</tbody>
</table>

*Covariate adjustment for age, sex, surgical status, primary diagnosis, comorbid illnesses, APACHE II, mechanical ventilation, acute kidney injury, and hospital site

Similar trends were seen when patients were stratified by MICU, SICU, CT ICU, and Sepsis.

Database analysis of 24 Australian ICUs: 66,184 adult ICU admissions for >24 hours from January 1, 2000 through December 31, 2005.
Blood Glucose and Risk of Infection Post Cardiac Surgery

<table>
<thead>
<tr>
<th>Post Op Blood Glucose</th>
<th>% Deep Surgical Wound Infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>% 100-150</td>
<td>1.3</td>
</tr>
<tr>
<td>% 151-200</td>
<td>1.6</td>
</tr>
<tr>
<td>% 201-250</td>
<td>2.5</td>
</tr>
<tr>
<td>% 251-300</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Consequences of Surgical Site Infections

- **Un-infected**
  - Mortality: 3.5%
  - ICU admission: 18%
  - Length of Stay: 6 days
  - Median Direct Cost: $3,844
  - Readmission: 7%

- **Infected**
  - Mortality: 7.8%
  - ICU admission: 29%
  - Length of Stay: 11 days
  - Median Direct Cost: $7,531
  - Readmission: 41%

"GOOD" Randomized Controlled Trials of glucose control in the ICU

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leuven I</th>
<th>Leuven II</th>
<th>VISEP</th>
<th>Glucontrol</th>
<th>NICE Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>SICU</td>
<td>MICU</td>
<td>Sepsis Mixed ICU</td>
<td>Mixed</td>
<td>Mixed</td>
</tr>
<tr>
<td>Centers</td>
<td>Single</td>
<td>Single</td>
<td>18</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td>Samp size</td>
<td>1548</td>
<td>1200</td>
<td>488/537</td>
<td>1011</td>
<td>~6030</td>
</tr>
<tr>
<td>Excluded</td>
<td>14</td>
<td>863</td>
<td>1,612</td>
<td>?</td>
<td>34,067</td>
</tr>
<tr>
<td>Stopped early</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Primary Diet</td>
<td>TPN 85%</td>
<td>TPN 85%</td>
<td>60% TPN</td>
<td>27% TPN</td>
<td>25% TPN</td>
</tr>
<tr>
<td>APACHE II</td>
<td>9</td>
<td>-23</td>
<td>-20</td>
<td>-15</td>
<td>-21</td>
</tr>
<tr>
<td>Mortality</td>
<td>ICU: ~7%</td>
<td>ICU: ~25%</td>
<td>ICU: ~40%</td>
<td>ICU: ~27%</td>
<td>ICU: ~16%</td>
</tr>
<tr>
<td>Target</td>
<td>80-110</td>
<td>80-110</td>
<td>80-110</td>
<td>80-110</td>
<td>81-108</td>
</tr>
<tr>
<td>Control</td>
<td>$180</td>
<td>$180</td>
<td>$180</td>
<td>$140-180</td>
<td>$144-180</td>
</tr>
<tr>
<td>Timing</td>
<td>ICU admit</td>
<td>ICU admit</td>
<td>&lt; 12 hrs</td>
<td>ICU or 56 day</td>
<td>Eating or 90 days</td>
</tr>
<tr>
<td>Duration</td>
<td>Entire ICU</td>
<td>Entire ICU</td>
<td>ICU 21 days</td>
<td>ICU or 56 day</td>
<td>Eating or 90 days</td>
</tr>
</tbody>
</table>

Intensive Insulin Therapy in Surgical ICU Patients

- **Conventional** *(n=783)*
  - Trigger blood glucose for starting insulin drip: >215 mg/dL
  - Achieved glucose: 153 mg/dL
  - Percent of patients on insulin drip: 39%

- **Intensive** *(n=765)*
  - Trigger blood glucose for starting insulin drip: >100 mg/dL
  - Achieved glucose: 103 mg/dL
  - Percent of patients on insulin drip: 99%

Intensive Insulin Therapy in Critically Ill Surgical Patients

- Mortality
  - Significantly improved in patients in ICU > 3 days

- Morbidity significantly reduced in all patients
  - Decreased weaning time from mechanical ventilation
  - Decreased time to discharge from ICU
  - Decreased time to discharge from the hospital
Mortality in RCT’s Targeting 80-110 mg/dL

<table>
<thead>
<tr>
<th>ICU</th>
<th>ITT</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leuven SICU</td>
<td>4.8</td>
<td>24.9</td>
</tr>
<tr>
<td>Leuven MICU</td>
<td>16.7</td>
<td>24.8</td>
</tr>
<tr>
<td>VISEP</td>
<td>16.7</td>
<td>24.8</td>
</tr>
<tr>
<td>Glucontrol</td>
<td>16.7</td>
<td>24.8</td>
</tr>
<tr>
<td>NICE-SUGAR</td>
<td>16.7</td>
<td>24.8</td>
</tr>
</tbody>
</table>

Mortality in Patients with Extended ICU Stays

<table>
<thead>
<tr>
<th>ICU</th>
<th>ITT</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leuven SICU &gt; 5 days</td>
<td>10.6</td>
<td>20.2</td>
</tr>
<tr>
<td>Leuven MICU &gt; 3 days</td>
<td>22.1</td>
<td>38.1</td>
</tr>
<tr>
<td>VISEP</td>
<td>31.3</td>
<td>22.3</td>
</tr>
<tr>
<td>Glucontrol</td>
<td>20.2</td>
<td>22.3</td>
</tr>
<tr>
<td>NICE-SUGAR</td>
<td>20.2</td>
<td>22.3</td>
</tr>
</tbody>
</table>

Were the Glycemic Goals of NICE-SUGAR Met?

- Intensive glucose goal: 80 – 108 mg/dL
- Conventional glucose goal: 144 – 180 mg/dL
- Mean time weighted blood glucose level
  115 ± 18 (intensive) vs 144 ± 23 (conventional)

Glycemic Separation in “Good” RCT’s Targeting 80-110 mg/dL

Time in 80-110 greater than 50% improves mortality?

Hypoglycemia in RCT’s Targeting 80-110 mg/dL

Hypoglycemia defined < 40 mg/dL

Subgroup analysis of glucontrol study

Multidisciplinary Guideline Guidance

<table>
<thead>
<tr>
<th>Society Of Thoracic Surgeons</th>
<th>Goal BG in ICU</th>
<th>Definition of Hypoglycemia</th>
<th>Goal BG in Severe Sepsis</th>
<th>Guidance on Insulin Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>180 mg/dL for cardiac surgery patients</td>
<td>None provided</td>
<td>None provided</td>
<td>Before intravenous insulin infusions are discontinued, patients should be transitioned to a subcutaneous insulin schedule using institutional protocols</td>
<td></td>
</tr>
<tr>
<td>ADA/AACE consensus statement</td>
<td>140–180 mg/dL</td>
<td>None provided</td>
<td>None provided</td>
<td>Use of validated insulin infusion protocols showed safety and efficacy, with low rates of hypoglycemia</td>
</tr>
<tr>
<td>ADA</td>
<td>&lt; 130 mg/dL</td>
<td>&gt; 70 mg/dL, severe &lt; 40 mg/dL</td>
<td>None provided</td>
<td>Avoid hypoglycemia</td>
</tr>
<tr>
<td>ACCM/SCCM</td>
<td>&lt; 130 mg, absolutely &lt; 180 mg/dL</td>
<td>70 mg/dL</td>
<td>None provided</td>
<td>Avoid hypoglycemia, monitor BG every 1–2 hr</td>
</tr>
<tr>
<td>Surviving Sepsis Campaign</td>
<td>None provided</td>
<td>Severe: &lt; 80 mg/dL</td>
<td>None provided</td>
<td>Avoid hypoglycemia, monitor BG every 1–2 hr until glucose values and insulin infusion rates are stable, followed by every 4 hr</td>
</tr>
<tr>
<td>ASPEN</td>
<td>140–180 mg/dL</td>
<td>≤ 70 mg/dL</td>
<td>None provided</td>
<td>None provided</td>
</tr>
</tbody>
</table>

Patient Case

TY is admitted to the Surgical Intensive Care Unit following an emergent thoracotomy requiring mechanical ventilation and vasopressor support. BG values are as follows: 1800: 231 mg/dL. 0000: 219. 0600: 267. In accordance with multidisciplinary guideline recommendations, which of the following should interventions be initiated to manage TY’s BG values?

A. Initiate metformin 500mg PO twice daily
B. Initiate a weight based subcutaneous insulin regimen consisting of Basal, Prandial and Correctional insulin
C. Initiate intravenous insulin infusion according to institutional protocol
D. Initiate a subcutaneous regular insulin via sliding scale every 6 hours

Target Blood Glucose: Patients Without Diabetes

Moderate glucose control is associated with increased mortality compared to tight glucose control in critically ill non-diabetics

Results:
- The longer a pt was on IV insulin the higher the risk of hypoglycemia
- Hypoglycemia was associated with 30-day crude mortality (independent of dx diagnosis)
  - BG never below 60 ≥ 13.3%
  - BG one reading < 60 ≥ 15.9%
  - BG one reading < 40 ≥ 17.3%
- Logistic regression model demonstrated:
  - Pts w/o diabetes, use of the 90–140 target was independently associated with an increased risk of mortality compared to the use of the 80–110 target
  - Pts w/ diabetes, use of the 90–140 target was independently associated with a decreased risk of mortality compared to the 80–110 target

What to take from this?
- The question is raised between the correlation of hypoglycemia, BG target, diabetic status, and mortality
- Glucometrics may be different in diabetics
  - Diabetic adaptation to chronic hyperglycemic state
- Glycemic variation correlation in critically ill
  - Pts w/DM have chronic glycemia dysregulation and may have adapatation over non-DM pts
- GLUT4 transporter protein, a signaling molecule that can affect myocardial function
  - Upregulated with exogenous insulin administration
  - Downregulated in a chronic hyperglycemic state

Target Blood Glucose: Patients With Diabetes

Moderate glucose control is associated with increased mortality compared to tight glucose control in critically ill non-diabetics
Barriers

- Health care system and workers
- No consensus regarding goals
- No published “how to” or standardized approach to testing and treatment
- Inadequate insulin drip protocol
- Compliance
- Fear of hypoglycemia
- Culture
- POCT and Lab
- Education
- Communication
- Healthcare resources

Continuous IV Insulin

- SC insulin is generally not recommended for critically ill patients
  - Severe or rapidly changing insulin requirements
  - Generalized edema or impaired perfusion of subcutaneous sites
  - Requirements for pressor support
  - Variable nutrition
- Efficacy
  - Insulin drips surpass the SC route with respect to rapidity of onset of effect and overall ability to achieve glycemic control
- Safety
  - Hypoglycemia (if it occurs) is short-lived

No Ideal Protocol in the Literature

- Many have been described
- Few have been rigorously evaluated
- Few are designed to reach goal of 80-110 mg/dL

The “Fixed” Protocol

<table>
<thead>
<tr>
<th>BBG (mg/dL)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 75</td>
<td>Stop insulin, treat if BBG &lt; 60</td>
</tr>
<tr>
<td>76 – 100</td>
<td>Stop insulin</td>
</tr>
<tr>
<td>101 – 125</td>
<td>If lower than previous test either decrease by 50% or 0.5 units/hour</td>
</tr>
<tr>
<td>126 – 150</td>
<td>Same rate</td>
</tr>
<tr>
<td>151 – 200</td>
<td>If lower than previous test, same rate</td>
</tr>
<tr>
<td>&gt; 200</td>
<td>If higher than previous test, increase by 0.5 units/hour</td>
</tr>
</tbody>
</table>

Multiplication Factor Concept

CURRENT RATE × ADJUSTMENT FACTOR (this factor based of rate of change in BBG over time) = NEW RATE

Initiating Continuous IV Insulin

http://www.bwh.harvard.edu/policies/Intravenous_Drug_Administration/DAG_InsulinProtocolBHIP.pdf
An Example Modification Protocol

<table>
<thead>
<tr>
<th>Current Blood Glucose (mg/dL)</th>
<th>Change in Blood Glucose Since the Prior Reading (mg/dL)</th>
<th>Decreased &gt; 30</th>
<th>Decreased 11–30</th>
<th>No Change ± 10</th>
<th>Increased 11–30</th>
<th>Increased &gt; 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 70</td>
<td>Hold insulin infusion and evaluate patient for hypoglycemia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70–110</td>
<td>x 0.25</td>
<td>x 0.50</td>
<td>x 0.75</td>
<td>Continue current rate</td>
<td>x 1.5</td>
<td>Continue current rate</td>
</tr>
<tr>
<td>111–150</td>
<td>x 0.50</td>
<td>x 0.75</td>
<td></td>
<td>Continue current rate</td>
<td>x 1.25</td>
<td>x 1.5</td>
</tr>
<tr>
<td>151–180</td>
<td>x 0.75</td>
<td></td>
<td></td>
<td>Continue current rate</td>
<td>x 1.5</td>
<td>x 2.0</td>
</tr>
<tr>
<td>181–210</td>
<td>Continue current rate</td>
<td>x 1.5</td>
<td></td>
<td>Continue current rate</td>
<td>x 2.0</td>
<td></td>
</tr>
<tr>
<td>&gt; 210</td>
<td>Continue current rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The above protocol can be used as a guide for the ICU team to account for the rate of change of BG between hourly BG checks. With each new BG result available, the prescriber, nurse, or ICU pharmacist can examine the relationship with the previous hour’s BG and the rate of change between the two. This chart will translate a mean BG of 145 mg/dL. The chart will then instruct the ICU team on how to adjust the insulin infusion rate according to a multiplication factor. Because calculations are often made for patients treated according to a protocol like this one, it is important to have safety checks in place to ensure the calculations are done accurately, either electronic or human double-check.

Advantages and Disadvantages of the “Multiplier” Protocol Concept

**Advantages**
- Higher glucose levels aggressively treated
- Big changes in glucose accounted for by decreasing multiplication factor
- Decrease hyperglycemia and hypoglycemia
- Computer-based system gives reminder for glucose check
- Improved glycemic control compared to fixed protocol

**Disadvantages**
- Computer
  - Expense and local issues related to information systems
- Paper
  - May not be as user friendly

Patient Case

- It is now POD 3, TY has now been successfully weaned from vasoactive support but remains intubated. TY is receiving a steady rate of 2.5 units/hour of insulin for the last 6 hours with POC BG values ranging from 145–162 mg/dL. He is on continuous enteral tube feeding. The SICU team consults the ICU pharmacist on how to transition off of the intravenous insulin infusion. What is the optimal response for transitioning TY to subcutaneous insulin?

A. TY should not be transitioned at this time because of persistent need for mechanical ventilation
B. TY is safe to transition, the infusion can be stopped and TY should be initiated on a SC sliding scale
C. TY is safe to transition, TY should be placed on SC insulin NPH 12 units twice daily and SC insulin regular 6 units every 6 hours, as well as a regular insulin sliding scale
D. TY is safe to transition, TY should be placed on SC insulin glargine 48 units SC daily as well as a regular insulin sliding scale

General Principles: Transition from I.V. to Subcutaneous Insulin

**Estimate total daily dose (TDD)**
- Average IV insulin rate over the past 6 hours
- Multiply by 24 to get 24hour requirements
- Multiply by 0.6ish to get TDD

~50% TDD

Basal

~50% TDD

Nutritional

SC Insulin Regimen

- **Basal**
  - Controls fasting and pre-meal glucose
  - Ideally included in every insulin regimen

- **Nutritional / Prandial**
  - Controls nutritional sources (discreet meals, TPN, tube feeds)
  - Ideally included in every insulin regimen

- **Correctional**
  - Used for the treatment of unexpected hyperglycemia
  - Ideally included in every insulin regimen

Hospitalized patients higher insulin doses, especially during initial stages of acute illness

Sliding Scale (Alone) Insulin:

- It doesn’t work!!
- Proactive insulin regimen is ideal versus a reactive sliding scale
- One size doesn’t fit all
- Increases risk for “stacking” of insulin and hypoglycemia
Avoid Insulin “Stacking”

Do NOT give sliding scale more frequently than every 4-6 hours to minimize risk of stacking.

Regular ~4-6 hours

<table>
<thead>
<tr>
<th>Time</th>
<th>BBG</th>
<th>Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 PM</td>
<td>400</td>
<td>10R</td>
</tr>
<tr>
<td>11 PM</td>
<td>360</td>
<td>10R</td>
</tr>
<tr>
<td>12 AM</td>
<td>280</td>
<td>10R</td>
</tr>
<tr>
<td>1 AM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 AM</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>3 AM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 AM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supplemental Scales

<table>
<thead>
<tr>
<th>Pre-meal BG</th>
<th>LOW Insulin/Day</th>
<th>MED Insulin/Day</th>
<th>HIGH Insulin/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 40 Units</td>
<td>1 unit</td>
<td>2 units</td>
<td>3 units</td>
</tr>
<tr>
<td>&gt; 40-80 Units</td>
<td>&gt; 40-80 Units</td>
<td>&gt; 80 Units</td>
<td></td>
</tr>
<tr>
<td>150-199</td>
<td></td>
<td>2 units</td>
<td></td>
</tr>
<tr>
<td>200-249</td>
<td>3 units</td>
<td>5 units</td>
<td></td>
</tr>
<tr>
<td>250-299</td>
<td>4 units</td>
<td>7 units</td>
<td></td>
</tr>
<tr>
<td>300-349</td>
<td>5 + call ho</td>
<td>8 + call ho</td>
<td>12 + call ho</td>
</tr>
</tbody>
</table>

Basal Insulin

- Either NPH or long-acting insulin
  - Also can be provided with regular insulin drip
- Should never be held in type 1 diabetes
- May sometimes, but not usually, be held or reduced if a type 2 diabetic patient is NPO

SC Insulin Regimen

<table>
<thead>
<tr>
<th>Type</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid acting</td>
<td>5-15 min</td>
<td>30-90 min</td>
<td>&lt; 5 hr</td>
</tr>
<tr>
<td></td>
<td>Insulin aspart (NovoLog)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insulin Lispro (Humalog)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insulin glulisine (Apidra)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short acting</td>
<td>30-60 min</td>
<td>2-3 hr</td>
<td>5-8 hr</td>
</tr>
<tr>
<td></td>
<td>Regular insulin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate acting</td>
<td>2-4 hr</td>
<td>4-10 hr</td>
<td>10-16 hr</td>
</tr>
<tr>
<td></td>
<td>NPH insulin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long acting</td>
<td>3-8 hr</td>
<td>Relatively peakless</td>
<td>6-23 hr</td>
</tr>
<tr>
<td></td>
<td>Insulin detemir (Levemir)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insulin glargine (Lantus)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Profiles of Available Insulins

- NPH
- Detemir (Levemir)
- Glargine (Lantus)
- Regular
- Lispro (Humalog)
- Aspart (NovoLog)
- Glulisine (Apidra)

Other points of consideration

- Does the rate / administration of TF matter?
  - Continuous vs bolus? How does this affect prandial insulin choice?

- What other considerations should you take when transitioning off of a continuous infusion insulin?
  - What’s the patient OR schedule?
  - Any planned interventions requiring cessation of TF?
  - Fluid overload/peripheral edema present?
Insulin Requirement For Patients Eating Discrete Meals or bolus tube feeds

- Insulin aspart (novolog)
- NPH insulin

Insulin Requirement For Patients Eating Discrete Meals or bolus tube feeds

- NPO
  - Hold prandial/mealtime insulin (insulin aspart)
- Continue basal insulin (NPH)

Insulin Requirement During Continuous Dextrose, TPN or Enteral Feedings

- Regular insulin R = Prandial insulin
- Insulin NPH = Basal Insulin

Insulin Requirement During Continuous Dextrose, TPN or Enteral Feedings

- Tube Feeds Off
  - Hold Regular insulin (prandial)
  - Continue NPH (basal)

Estimating Initial Insulin Regimen

Estimate Total Daily Dose (TDD)

0.5 Units/kg/day * 60 kg = 30 units

- 50% TDD
  - BASAL
  - ~15 units
- 50% TDD
  - NUTRITIONAL
  - ~15 units

Patient Case

- It is now POD 3, TY has now been successfully weaned from vasoactive support but remains intubated. TY is receiving a steady rate of 2.5 units/hour of insulin for the last 6 hours with POC BG values ranging from 145-162 mg/dL. He is on continuous enteral tube feeding. The SICU team consults the ICU pharmacist on how to transition off of the intravenous insulin infusion. What is the optimal response for transitioning TY to subcutaneous insulin?
  A. TY should not be transitioned at this time because of persistent need for mechanical ventilation
  B. TY is safe to transition, the infusion can be stopped and TY should be initiated on a SC sliding scale
  C. TY is safe to transition, TY should be placed on SC insulin NPH 12 units twice daily and SC insulin regular 6 units every 6 hours, as well as a regular insulin sliding scale
  D. Ty is safe to transition, TY should be placed on SC insulin glargine 48 units SC daily as well as a regular insulin sliding scale
Peri-operative Glucose Management

- Patient TY (T2DM) is scheduled for a procedure tomorrow afternoon
- Today on rounds, the team decides patient will be made NPO after midnight
- Current regimen:
  - Glargine 20 units HS
  - Aspart 8 units QAC
  - Aspart sliding scale QAC + HS

What do we do about the insulin orders?

Patient Case

- It is now POD 5, TY remains in the SICU, but is now eating discrete meals and is stable on an insulin regimen of insulin glargine 20 units SC daily, insulin aspart 8 units SC with meals as well as an insulin aspart sliding scale with meals and at bedtime. TY will have to return to the OR tomorrow for a minor procedure, but be made NPO at midnight. What adjustments should be made to TY’s insulin regimen?

  A. Give insulin glargine, hold insulin aspart standing as well as supplemental insulin aspart
  B. Give 10 units of insulin glargine and reassess after procedure
  C. Hold all insulin orders until post procedure
  D. Hold insulin glargine and insulin aspart standing doses and use supplemental aspart

Patient Case

- It is now POD 5, TY remains in the SICU, but is now eating discrete meals and is stable on an insulin regimen of insulin glargine 20 units SC daily, insulin aspart 8 units SC with meals as well as an insulin aspart sliding scale with meals and at bedtime. TY will have to return to the OR tomorrow for a minor procedure, but be made NPO at midnight. What adjustments should be made to TY’s insulin regimen?

  A. Give insulin glargine, hold insulin aspart standing as well as supplemental insulin aspart
  B. Give 10 units of insulin glargine and reassess after procedure
  C. Hold all insulin orders until post procedure
  D. Hold insulin glargine and insulin aspart standing doses and use supplemental aspart

Patient TY Post-Op

- Admitted to SICU post-op
- Tube feeds will be initiated
  - Jevity 1.5 (goal rate 65mL/hr)
  - Pre-op regimen glargine and aspart

  What do you want to do for TY’s insulin regimen?

  - A: Give basal, hold prandial, use supplemental
  - B: Switch regimen to regular insulin Q6H with regular sliding scale
  - C: Re-initiate the aspart standing and sliding scale
  - D: Increase prandial to meet new caloric intake

Conclusions

- Diabetes and hyperglycemia are associated with:
  - Increased length of stay
  - Increased hospitalization
  - Increase mortality
  - Increase cost to the health care system
  - Increase rate of infection

- Insulin is most likely the most effective and safest treatment of inpatient hyperglycemia

- Insulin regimens should be physiologically based
Take-Home Messages

- Patients that should be started on IV insulin
  - Hyperglycemic (greater than 140?, 180?, after failed SC regimen?)
  - Will be in the unit for at least a day (best result >3 day)
  - Non-diabetics more at risk?
- Use a validated institutional protocol shown to avoid hypoglycemia
  - IV insulin in the safest insulin in ICU
- IV to SC transition
  - Generally 60-80% of calculated TDD divided into:
    - 50% Basal
    - 50% Nutritional Insulin
- Create easily accessible order sets to standardize care