Inpatient Hyperglycemia

Rational Approach at a Time of Uncertainty

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What is inpatient diabetes care?

Diabetes as a Secondary Diagnosis
Inpatient Diabetes Goals

Who Cares
Just get patient home
Sliding Scales are fine
Avoid that scary hypoglycemia

Inpatient Diabetes Goals

Normal glucoses for everyone
A high glucose means failure
Sliding Scales are banned
Some hypoglycemia is acceptable

---

AACE Position Statement: Hospital Glycemic Goals

Intensive Care Units: 110 mg/dL

Non-Critical Care Units:
Pre-Prandial 110 mg/dL
Max. Glucose 180 mg/dL
Inpatient Diabetes Goals

Who Cares
Just get patient home
Sliding Scales are fine
Avoid that scary hypoglycemia

Normal glucose levels for everyone
A high glucose means failure
Sliding Scales are banned
Some hypoglycemia is acceptable

Appropriate Glucose Control Based on physiology and outcome studies

Recommendation 1: ACP recommends not using intensive insulin therapy to strictly control blood glucose in non-surgical intensive care unit (SICU)/medical intensive care unit (MICU) patients with or without diabetes mellitus (Grade: strong recommendation, moderate-quality evidence).

Recommendation 2: ACP recommends not using intensive insulin therapy to normalize blood glucose in SICU/MICU patients with or without diabetes mellitus (Grade: strong recommendation, high-quality evidence).

Recommendation 3: ACP recommends a target blood glucose level of 7.8 to 11.1 mmol/L (140 to 200 mg/dL) if insulin therapy is used in SICU/MICU patients (Grade: weak recommendation, moderate-quality evidence).
Target Glucose Levels

Alive

No DKA or Hyperosmolar Coma
Occasional hypo- and hyperglycemia

No hypo- or hyperglycemia

- Prevent fluid and electrolyte abnormalities secondary to osmotic diuresis
- Improve WBC function
- Improve gastric emptying
- Decrease surgical complications
- Decrease post-MI mortality
- Decrease post-CABG morbidity and mortality
- Earlier hospital discharge
Target Glucose Levels

Normal Glucoses

Decreased Morbidity and Mortality

Problems With High Glucoses
Proinflammatory cytokines in response to DKA

- In DKA—increased 2-3 fold:
  - counterregulatory hormones
  - proinflammatory cytokines
    - (tumor necrosis factor [TNF]–α,
    - interleukin [IL]-6, IL-8, and IL-1β),
  - markers of reactive oxygen species
  - markers of lipid peroxidation
  - C-reactive protein, and free fatty acids

Metabolism 2009, 58: 443-448

Glucose and Post-CABG Morbidity and Mortality

Diabetes and Coronary Artery Bypass Surgery
An examination of perioperative glycemic control and outcomes

- Retrospective review of 291 patients surviving 24 h post-op
- 40% with retinopathy, nephropathy, or neuropathy

Inpatient complications:
For each 1 mmol/l (18 mg/dL) increase in post-op day 1 over 6.1 mmol/l (110 mg/dL), a 17% increased risk of complications

High Blood Glucose Levels Associated With Increased Mortality in ICU

- Retrospective review of 259,040 critically ill patients conducted by the Veterans Affairs Inpatient Evaluation Center based in Cincinnati

- Hyperglycemia was an independent predictor of mortality starting at 111 mg/dL
- Effect was greatest with acute myocardial infarction, unstable angina, and stroke
  - Raised MI risk from 1.7 to 6 times
  - Raised stroke risk from 1.8 to 29 times
  - Raised unstable angina from 1.4 to 3 times


- A significant but weaker effect was seen in patients with sepsis, pneumonia, and pulmonary embolism
- Hyperglycemia was not found to be associated with mortality in diseases such as COPD and hepatic failure, hip fractures
- In diabetes patients, the increase in mortality risk was not seen until mean glucose was >146 mg/dL

Hyperglycemia–related mortality in critically ill patients varies with admission diagnosis


TPN: Adverse Outcomes
Hyperglycemia Is Associated With Adverse Outcomes in Patients Receiving Total Parenteral Nutrition
Cheung et al: Diabetes Care, 28:2367-2371, 2005

Risk of complications in relation to mean daily blood glucose level

<table>
<thead>
<tr>
<th>Complication</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any infection</td>
<td>1.40 (1.08–1.82)</td>
<td>0.01</td>
</tr>
<tr>
<td>Septicemia</td>
<td>1.36 (1.00–1.86)</td>
<td>0.05</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>1.47 (1.00–2.17)</td>
<td>0.05</td>
</tr>
<tr>
<td>Cardiac complications</td>
<td>1.61 (1.09–2.37)</td>
<td>0.02</td>
</tr>
<tr>
<td>Death</td>
<td>1.77 (1.23–2.52)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Any complication</td>
<td>1.58 (1.20–2.07)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
The association of mean glucose level and glucose variability with intensive care unit mortality in patients with severe acute pancreatitis

Intervention Studies

Decreased Infections
Insulin infusion improves neutrophil function in diabetic cardiac surgery patients

Perioperative IV insulin infusion

<table>
<thead>
<tr>
<th>Neutrophil phagocytic activity</th>
<th>% baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>47</td>
</tr>
<tr>
<td>Insulin</td>
<td>75</td>
</tr>
</tbody>
</table>

Decreased Infections
Glucose control lowers the risk of wound infection in diabetics after open-heart operations

Perioperative IV insulin infusion
Protocol to maintain glucooses <200 mg/dL

<table>
<thead>
<tr>
<th>Incidence of Deep Wound Infections (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
</tr>
<tr>
<td>Routine Control</td>
</tr>
<tr>
<td>“Tight” Control</td>
</tr>
</tbody>
</table>


Decreased Mortality
Glucose control decreases mortality in diabetics after open heart operations

Declining In-Hospital Mortality in Patients Undergoing Coronary Bypass Surgery in the United States Irrespective of Presence of Type 2 Diabetes or Congestive Heart Failure

Steady decline in the age-adjusted coronary artery bypass grafting (CABG)-related in-hospital mortality in recent years. (X/100,000)

Intensive Insulin Therapy in Critically Ill Patients

- Patients (all) on mechanical ventilation in ICU
- Randomly assigned to IV insulin maintaining glucose between 80-110 mg/dL or conventional treatment (IV insulin if glucose >215 mg/dL then maintain glucose between 180-200)

<table>
<thead>
<tr>
<th></th>
<th>12 month mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive</td>
<td>4.6%</td>
</tr>
<tr>
<td>Conventional</td>
<td>8.6%</td>
</tr>
</tbody>
</table>

Main effect on patients in ICU >5 days

NICE-SUGAR

- 6104 adults who were expected to require treatment in the ICU on 3 or more consecutive days randomized to intensive blood glucose control (target range, 81 to 108 mg/dL) or conventional blood glucose control (<180 mg/dL)

- Primary endpoint death from any cause within 90 days after randomization

- Baseline characteristics similar

NICE-SUGAR: Data on Blood Glucose Level, According to Treatment Group


NICE-SUGAR: Probability of Survival and Odds Ratios for Death, According to Treatment Group

Proinflammatory cytokines in response to insulin-induced hypoglycemic stress in healthy subjects

- In hypoglycemia—an increased 2-3 fold:
  - counterregulatory hormones
  - WBC
  - proinflammatory cytokines
    - (tumor necrosis factor [TNF]-α,
    - interleukin [IL]-6, IL-8, and IL-1β),
  - markers of reactive oxygen species
  - markers of lipid peroxidation
  - free fatty acids

Metabolism 2009, 58: 443-448
Hypoglycemia and Mortality in Insulin-treated vs Non–Insulin-treated AMI Patients


Hypoglycemia was a predictor of higher mortality in patients not treated with insulin, but not in patients treated with insulin.

Hazard Ratio for Death According to the Occurrence of Hypoglycemia on 1 Day or More Than 1 Day and Receipt or Nonreceipt of Insulin Therapy at the Time of the First Hypoglycemic Episode.

Severe Hypoglycemia (glucose<40 mg/dl)
4 month audit

<table>
<thead>
<tr>
<th>Unit</th>
<th>Total Glucose Checks</th>
<th># Low from report (% low)</th>
<th>False lows</th>
<th># of Actual Low (% low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU (IV)</td>
<td>3378</td>
<td>3 (0.09%)</td>
<td>2/3</td>
<td>1 (0.03%)</td>
</tr>
<tr>
<td>ICU (SQ)</td>
<td>5241</td>
<td>9 (0.17%)</td>
<td>8/9</td>
<td>1 (0.02%)</td>
</tr>
<tr>
<td>Med/Surg</td>
<td>15661</td>
<td>18 (0.11%)</td>
<td>17/18</td>
<td>1 (&lt;0.01%)</td>
</tr>
</tbody>
</table>

False Low explanation

<table>
<thead>
<tr>
<th>Unit</th>
<th>Total False lows</th>
<th>Immediate repeat not low (and no rx given)</th>
<th>No low glucose found (and no rx noted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU (IV)</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>ICU (SQ)</td>
<td>8</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Med/Surg</td>
<td>17</td>
<td>12</td>
<td>5</td>
</tr>
</tbody>
</table>

In ICU, both patients with lows did die within 24 hours, but on review, these patients were both end stage and plans were already being discussed for withdrawal of life support prior to the low glucose.

2014 Inpatient Glucose Goals

<table>
<thead>
<tr>
<th>Organization</th>
<th>ICU</th>
<th>Non-ICU Preandial</th>
<th>Non-ICU Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>AACE/ACE</td>
<td>140-180 mg/dl</td>
<td>&lt;140 mg/dl</td>
<td>180 mg/dl</td>
</tr>
<tr>
<td>ADA</td>
<td>140-180 mg/dl</td>
<td>&lt;140 mg/dl</td>
<td>180 mg/dl</td>
</tr>
<tr>
<td>ACP</td>
<td>140-200 mg/dl</td>
<td>Avoid &lt;140 mg/dl</td>
<td></td>
</tr>
<tr>
<td>Endocrine Society</td>
<td></td>
<td>&lt;140 mg/dl</td>
<td>180 mg/dl</td>
</tr>
<tr>
<td>Society of Critical Care Medicine</td>
<td>100-150 mg/dl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UCSF</td>
<td>100-160 mg/dl</td>
<td>100-180 mg/dl</td>
<td></td>
</tr>
</tbody>
</table>
Mean Blood Glucose Levels During Insulin Therapy

![Graph showing blood glucose levels during insulin therapy with days of therapy on the x-axis and blood glucose levels on the y-axis. The graph compares blood glucose levels for SSRI and Lantus + glulisine treatments.]

* p<0.01
¶ p<0.05
Day 3: ¶ p=0.06


Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes (RABBIT 2 Trial-surgery)

Changes in blood glucose concentrations in patients treated with SSI (•) and with glargine plus glulisine (○).

Diabetes Care 34:1–6, 2011
Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes (RABBIT 2 Trial-surgery)

How to Obtain “Tight” Control

- Bedside glucose monitoring
- IV insulin drips
- Diabetic Flow sheets
- Discourage the use of traditional *Sliding Scale* insulin
Mr. And Mrs. XXXXX are admitted for “Giants” fever.

Mr. XXXXX has Type 2 diabetes and takes a total of 75 Units insulin per day (2 shots). Glucoses at home are “poorly controlled.”

Mrs. XXXXX also has Type 2 diabetes but she has good control taking about 25 units of Lispro premeal and 40 Units glargine at night.
Fingerstick qid with regular insulin SQ coverage:

FSBG  Action
< 50  1 amp D50 iv and call HO
51-80  give juice and repeat in 0.5-1 hr
81-150 no coverage
151-200 2U regular insulin SQ
201-250 4U regular insulin SQ
251-300 6U regular insulin SQ
301-350 8U regular insulin SQ
351-400 10U regular insulin SQ
>400  12U regular insulin SQ, call HO

INSULIN SLIDING SCALE
Use of Insulin

Physiologic Insulin Secretion: Basal/Bolus Concept

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Basal Insulin (µUnits/mL)</th>
<th>Nutritional (Prandial) Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.M.</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>P.M.</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

Suppresses glucose production between meals & overnight

The 50/50 Rule
The Components of a Physiologic Insulin Regimen

- Basal insulin
- Nutritional insulin
- Correctional insulin
Insulin Regimens

Relative Insulin Level

12pm Breakfast Lunch Dinner

Time

BID NPH

NPH

Insulin Regimens

Relative Insulin Level

12pm Breakfast Lunch Dinner

Time

BID R and NPH

regular
Insulin Regimens

Relative Insulin Level

12pm | Breakfast | Lunch | Dinner

- **TID R and hs NPH**
  - regular
  - NPH

- **PM glargine**
  - NPH
  - glargine
### Insulin Regimens

#### Relative Insulin Level

- **TID lispro/aspart/glulisine and hs glargine**

#### Time

- **12pm**
- **Breakfast**
- **Lunch**
- **Dinner**

### Insulin Order Forms

- **Adult**
  - DKA
  - Adult SQ Insulin – Patient eating
  - Adult SQ Insulin – NPO, TPN, Tube Feeding
  - IV insulin – ICU protocol
  - IV insulin – Med-Surgical Unit protocol
  - Adult Insulin pump
    - Patient waiver form
  - Adult SQ insulin algorithm for NPO patients**
  - CV Surgery Specific orders
  - PREO-OP Pathway**

- **OB-GYN**
  - SQ Insulin – Patient eating
  - IV Insulin form - delivery
  - Pump Form
    - Pump waiver form

- **Pediatrics**
  - SQ Insulin – Patient eating
  - Pump Form
    - Pump waiver
  - DKA
  - IV insulin

**under development**
## Subcutaneous Insulin Order Sheet

### Introduction

<table>
<thead>
<tr>
<th>Order set</th>
<th>Premeal Dosing</th>
<th>Postmeal Dosing (based on amount consumed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult SQ Insulin – Patient eating: set premeal dose</td>
<td>Premeal Dosing</td>
<td>Postmeal Dosing (based on amount consumed)</td>
</tr>
<tr>
<td>Adult SQ Insulin – Patient eating: CHO Counting</td>
<td>Premeal Dosing CHO dependent</td>
<td>Postmeal Dosing (based on CHO consumed)</td>
</tr>
<tr>
<td>Adult SQ Insulin – NPO, TPN</td>
<td>Q4h nutrition and correction</td>
<td>Nutrition dose timed to cycle TPN, correction q4h</td>
</tr>
<tr>
<td>Adult SQ Insulin – Tube Feeding</td>
<td>Q4h nutrition and correction</td>
<td>Nutrition dose timed to cycle feedings, correction q4h</td>
</tr>
<tr>
<td>Adult Insulin Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV Insulin protocol: ICU</td>
<td>Specific initial rate for CVS/DKA/other</td>
<td></td>
</tr>
<tr>
<td>IV Insulin protocol: Medical/surgical units</td>
<td>Specific initial rate for CVS/DKA/other</td>
<td></td>
</tr>
<tr>
<td>DKA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Subcutaneous Insulin Order Sheet:
- PATIENT EATING

Check blood glucose and give insulin before meals, bedtime, and 2 A.M.
1. Discontinue previous SQ insulin order.
2. If patient becomes NPO for procedure/stops eating:
   - **HOLD** nutritional dose of Aspart
     - Give correctional dose of Aspart if BG >130 mg/dL.
     - Give Glargine dose. If BG has been <70 mg/dL in last 24 hours, call MD to consider adjusting Glargine dose.
     - Call MD for SQ insulin NPO orders if patient on 70/30, NPH insulin or has been NPO for >12 hours.

### BASAL AND NUTRITIONAL INSULIN DOSE (IN UNITS)

<table>
<thead>
<tr>
<th>Patient Eating TIME</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspart (Novolog)</td>
<td>Nutritional Dose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novolog Mix 70/30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SUBCUTANEOUS INSULIN ORDER SHEET: MEAL TIME INSULIN ADJUSTMENTS

#### B. Meal Time CORRECTIONAL Insulin with ASPART
Check box to choose scale. Add or subtract from nutritional dose of aspart.

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>Sensitive BMI less than 25 and/or &lt;50 units per day</th>
<th>Average BMI 25-30 and/or 50-80 units per day</th>
<th>Resistant BMI &gt;30 and/or &gt;90 units per day</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dl</td>
<td>Treat for hypoglycemia per protocol (see order #3). Once BG ≥100 mg/dL, give Aspart with following change when patient eats.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70-100 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>101-130 mg/dl</td>
<td>2 units less</td>
<td>2 units less</td>
<td>3 units less</td>
<td>units less</td>
</tr>
<tr>
<td>131-150 mg/dl</td>
<td>+0 unit</td>
<td>+1 units</td>
<td>+2 units</td>
<td>+____ units</td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>+1 units</td>
<td>+2 units</td>
<td>+3 units</td>
<td>+____ units</td>
</tr>
<tr>
<td>201-250 mg/dl</td>
<td>+2 units</td>
<td>+4 units</td>
<td>+6 units</td>
<td>+____ units</td>
</tr>
<tr>
<td>251-300 mg/dl</td>
<td>+3 units</td>
<td>+6 units</td>
<td>+9 units</td>
<td>+____ units</td>
</tr>
<tr>
<td>301-350 mg/dl</td>
<td>+4 units</td>
<td>+8 units</td>
<td>+12 units</td>
<td>+____ units</td>
</tr>
<tr>
<td>351-400 mg/dl</td>
<td>+5 units</td>
<td>+10 units</td>
<td>+15 units</td>
<td>+____ units</td>
</tr>
<tr>
<td>Over 400 mg/dl</td>
<td>+6 units</td>
<td>+12 units</td>
<td>+18 units</td>
<td>+____ units</td>
</tr>
</tbody>
</table>
Subcutaneous Insulin Order Sheet: Bedtime and 2am insulin adjustments

Shown below is the section C the page for “patients eating”. The area indicates the orders for supplemental insulin that should be given at bedtime and/or 2am. Aspart insulin is to be used at these times. These testing times are important not just for checking for high glucomes but also to monitor and treat low glucomes. These checks are also important in helping to adjust the overall insulin doses.

**C. BEDTIME AND 2AM BLOOD GLUCOSE CORRECTIONAL INSULIN WITH ASPART IF BG ≥ 200mg/dl**

<table>
<thead>
<tr>
<th>BG Range</th>
<th>Default Value</th>
<th>Or Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-250 mg/dL</td>
<td>1 unit</td>
<td></td>
</tr>
<tr>
<td>251-300 mg/dL</td>
<td>2 units</td>
<td></td>
</tr>
<tr>
<td>&gt;300 mg/dL</td>
<td>3 units</td>
<td></td>
</tr>
</tbody>
</table>

Subcutaneous Insulin Order Sheet: NPO, Tube Feeds or TPN

1. NPO _____________________ (start date / time)
TPN continuous cycle _______________
TUBE FEED continuous cycle ______________

1. Check blood glucose and give insulin every 4 hours.
2. Discontinue previous SQ insulin order.
3. If patient becomes NPO for procedure/stops eating:
   - Hold nutritional doses of Aspart
   - Give correctional dose of Aspart if BG>130 mg/dl
   - Give Glargine dose. If BG has been less than 70 mg/dl in last 24 hours, call MD to consider adjusting glargine dose.
4. If TPN/Tube Feed interrupted >30 minutes, hang D10W at rate of Tube Feed/TPN

A. BASAL AND NUTRITIONAL INSULIN DOSE (IN UNITS)

<table>
<thead>
<tr>
<th>BLOOD GLUCOSE TIME</th>
<th>6:00</th>
<th>10:00</th>
<th>14:00</th>
<th>18:00</th>
<th>22:00</th>
<th>02:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspart (Novolog)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Nutritional Dose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The final section of both forms of the order sheets describes the treatment for hypoglycemia. The key item is that when a person can eat, the hypoglycemia is treated by oral glucose.

**Low Glucose Reading**

For BG < 70 mg/dL, use Hypoglycemia Protocol below. These hypoglycemia orders remain active for duration of SQ insulin administration.

- For patient taking PO, give 20 gm of oral fast-acting carbohydrate per patient preference:
  - 20 grams glucose PO. Repeat Q 15 minutes until BG ≥ 100 mg/dL.
  - 6 oz. fruit juice. Repeat Q 15 minutes until BG ≥ 100 mg/dL.
  - 25 mL D50W IV push if patient cannot take PO. Repeat Q 15 minutes until BG ≥ 100 mg/dL.
  - Check fingerstick glucose every 15 minutes and repeat treatment until BG is ≥ 100 mg/dL.

**Transition from IV to SQ Insulin**

Take 80% of last 24 h insulin infusion

- Basal: $\frac{1}{2}$ of the value
- Premeal: $\frac{1}{2}$ of the value divided for the meals

Example: 1.5 units per hour = 36U

- $36 \times 0.8 = 29$
- Basal: $30 \times 0.5 = 15$
- Premeal: $30 \times 0.5 = 15 \quad 5$ per meal
**Transition from IV to SQ**

A. **Basal and Nutrition Insulin Dose (In Units):** Check blood glucose before meal, bedtime and 2am.

- If patient becomes NPO: Hold nutritional dose of Aspart and give correctional dose of Aspart if BG >130 mg/dl.
- If patient is NPO >4 hours call MD for IV Dextrose order.

<table>
<thead>
<tr>
<th>Patient Eating Time</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspart (Novolog)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Basal + Nutritional</td>
<td></td>
<td></td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

B. **Meal Time Correctional Insulin with Aspart:** Check box to choose scale. Add or subtract from nutritional dose of Aspart.

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>Sensitive (BMI less than 25 and/or &lt;50 units per day)</th>
<th>Average (BMI 25-30 and/or 50-90 units per day)</th>
<th>Resistant (BMI &gt;30 and/or &gt;90 units per day)</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td></td>
</tr>
<tr>
<td>70-100 mg/dl</td>
<td>2 units less</td>
<td>2 units less</td>
<td>3 units less</td>
<td></td>
</tr>
<tr>
<td>101-150 mg/dl</td>
<td>1 unit</td>
<td>1 unit</td>
<td>2 units</td>
<td></td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>2 units</td>
<td>3 units</td>
<td>-6 units</td>
<td></td>
</tr>
<tr>
<td>201-300 mg/dl</td>
<td>3 units</td>
<td>4 units</td>
<td>-6 units</td>
<td></td>
</tr>
<tr>
<td>301-400 mg/dl</td>
<td>4 units</td>
<td>5 units</td>
<td>-9 units</td>
<td></td>
</tr>
<tr>
<td>401-500 mg/dl</td>
<td>5 units</td>
<td>6 units</td>
<td>-12 units</td>
<td></td>
</tr>
<tr>
<td>&gt;500 mg/dl</td>
<td>6 units</td>
<td>7 units</td>
<td>-15 units</td>
<td></td>
</tr>
</tbody>
</table>

**Transition from IV to SQ Insulin**

What to do if unclear how much the patient will eat? What if transition to clear liquids?

1. Basal calculation remains unchanged

2. Premeal 0-50% of calculated dose
### Transition from IV to SQ

**A. Basal and Nutrition Insulin Dose (in units):** Check blood glucose before meal, bedtime and 2am.
- If patient becomes NPO HOLD nutritional dose of Aspart and give correctional dose of Aspart if BG >130 mg/dl
- If patient is NPO >4 hours call MD for IV Dextrose order.

<table>
<thead>
<tr>
<th>Patient Eating TIME</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspart (Novolog)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**B. Meal Time Correctional Insulin with Aspart.** Check box to choose scale. Add or subtract from nutritional dose of aspart.

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>Sensitive (BMI less than 25 and/or &lt;50 units per day)</th>
<th>Average (BMI 25-30 and/or 75-90 units per day)</th>
<th>Resistant (BMI &gt;30 and/or &gt;90 units per day)</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>70-100 mg/dl</td>
<td>2 units less</td>
<td>2 units less</td>
<td>3 units less</td>
<td>units less</td>
</tr>
<tr>
<td>101-130 mg/dl</td>
<td>3 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>131-150 mg/dl</td>
<td>4 units less</td>
<td>4 units less</td>
<td>5 units less</td>
<td>units less</td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>5 units less</td>
<td>5 units less</td>
<td>6 units less</td>
<td>units less</td>
</tr>
<tr>
<td>201-300 mg/dl</td>
<td>6 units less</td>
<td>6 units less</td>
<td>7 units less</td>
<td>units less</td>
</tr>
<tr>
<td>301-500 mg/dl</td>
<td>7 units less</td>
<td>7 units less</td>
<td>8 units less</td>
<td>units less</td>
</tr>
<tr>
<td>Over 500 mg/dl</td>
<td>8 units less</td>
<td>8 units less</td>
<td>9 units less</td>
<td>units less</td>
</tr>
</tbody>
</table>

### Adjusting Insulin

**Basal Insulin:**

Generally, the basal insulin dose is adjusted based on fasting glucose levels. For example, based on today's results, new orders for tomorrow:

- if FBS <140, no change
- if FBS 141-160, increase basal dose by 2-3 units
- if FBS 160-180, increase basal dose by 4-5 units
- if FBS 180-200, increase basal dose by 6-7 units
- if FBS >200, increase basal dose by 8 units

With this approach, the basal insulin can be titrated up to the patient's actual requirement relatively quickly. As always, the actual changes in the insulin doses depend on the patient's clinical situation and thus no formula will ever really work, but guidelines such as this give you a reasonable approach. Just to be clear, this is not a "sliding scale" for basal insulin!! You would NEVER do that. These are suggestions for rewriting the basal dose.

If the patient has been receiving their basal insulin as a split dose with both morning and evening dosing, you can generally split the increase in the dose.
Adjusting Insulin

Nutritional Insulin:

The adequacy of the nutritional insulin (premeal) dose is based on the glucose level prior to the next meal (or bedtime for the dinner dose).

For example, the glucose level just before lunch will indicate whether the insulin given at breakfast was appropriate. The glucose level at bedtime will indicate whether the insulin given at dinner was appropriate.

<table>
<thead>
<tr>
<th>Prebreakfast glucose</th>
<th>Insulin given for breakfast (nutritional + correction)</th>
<th>Prelunch glucose</th>
<th>Intervention for next day Nutritional prebreakfast dose next day</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>210</td>
<td>If there is no significant change in the glucose level from before breakfast to before lunch, then the dose of insulin the patient received at breakfast (nutritional plus correction) would be an appropriate nutritional dose for breakfast the next day 7 units</td>
</tr>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>260</td>
<td>If there is a significant increase in the glucose level from before breakfast to before lunch, then the dose of insulin the patient received at breakfast (nutritional plus correction) would need to be increased and become the nutritional dose for breakfast the next day 8 units</td>
</tr>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>138</td>
<td>If the glucose level before breakfast had been high, and the glucose level at lunch is at goal, then no change in the nutritional dose will be required for the next day 5 units</td>
</tr>
<tr>
<td>220</td>
<td>5 + 2 = 7 units</td>
<td>60</td>
<td>No matter what the glucose level was at breakfast, if the glucose level after breakfast or before lunch is low, then the breakfast nutritional dose needs to be decreased for the next day 3 units</td>
</tr>
</tbody>
</table>
**Cases: IVE**

Patient IVE is a 83 year old male. s/p cardiac surgery. Has been on IV insulin, with well controlled glucose. Patient remains in critical condition, IV insulin is to be continued and patient is also starting to eat.

<table>
<thead>
<tr>
<th>TIME</th>
<th>600</th>
<th>700</th>
<th>800</th>
<th>900</th>
<th>1000</th>
<th>1100</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>125</td>
<td>132</td>
<td>240</td>
<td>260</td>
<td>220</td>
<td>130</td>
<td>50</td>
</tr>
<tr>
<td>Insulin (units/h)</td>
<td>1</td>
<td>1</td>
<td>2.2</td>
<td>3.4</td>
<td>4.4</td>
<td>3.9</td>
<td></td>
</tr>
</tbody>
</table>

Breakfast
Patient on Insulin who is Eating

- In general - continue patient's normal outpatient insulin regimen
- Consider decrease to 70% to decrease risk of hypoglycemia
- Do not stop the outpatient insulin and use a sliding scale
- If outpatient glucoses have been poorly controlled on current insulin regimen, consider starting more appropriate insulin regimen

Patien on Insulin who is Eating

Patient on
40Uam,30Upm of
70/30
Poorly controlled,
80kg
30 U glargine
10U aspart/humalog premeal

Easy method:
Choose the U/kg (.3 to .5 U/kg)
Basal: ½ of the value
premeal: ½ of the value divided for the meals
If on premixed insulin changing to MDI:
Basal: ½ of the total dose
premeal: ½ of the total dose divided for the meals
A. **BASAL AND NUTRITION INSULIN DOSE (IN UNITS):** Check blood glucose before meal, bedtime and 2am.

- If patient becomes NPO HOLD nutritional dose of Aspart and give correctional dose of Aspart if BG >130 mg/dl
- If patient is NPO >4 hours call MD for IV Dextrose order

<table>
<thead>
<tr>
<th>Patient Eating TIME</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspart (Novolog)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. **Meal Time CORRECTIONAL Insulin with ASPART.** Check box to choose scale. Add or subtract from nutritional dose of Aspart

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>Sensitive BMI &lt;35 and/or &lt;50 units per day</th>
<th>Average BMI 35-39 and/or 50-90 units per day</th>
<th>Resistant BMI &gt;39 and/or &gt;90 units per day</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dl</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BG ≥100 mg/dl</td>
<td>Treat for hyperglycemia per protocol (see order #5). Once BG ≥100 mg/dl, give Aspart with following change when patient eats.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70-100 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td></td>
</tr>
<tr>
<td>101-130 mg/dl</td>
<td>2 units less</td>
<td>2 units less</td>
<td>3 units less</td>
<td></td>
</tr>
<tr>
<td>131-150 mg/dl</td>
<td>+1 unit</td>
<td>+2 units</td>
<td>+3 units</td>
<td></td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>2 units less</td>
<td>2 units less</td>
<td>3 units less</td>
<td></td>
</tr>
<tr>
<td>201-250 mg/dl</td>
<td>+1 unit</td>
<td>+2 units</td>
<td>+3 units</td>
<td></td>
</tr>
<tr>
<td>251-300 mg/dl</td>
<td>+1 unit</td>
<td>+2 units</td>
<td>+3 units</td>
<td></td>
</tr>
<tr>
<td>301-400 mg/dl</td>
<td>+1 unit</td>
<td>+2 units</td>
<td>+3 units+1 units</td>
<td></td>
</tr>
<tr>
<td>Over 400 mg/dl</td>
<td>+1 unit</td>
<td>+2 units</td>
<td>+3 units+1 units</td>
<td></td>
</tr>
</tbody>
</table>

**Change for next day would be increase in Breakfast and lunch Aspart**

### Glucose

<table>
<thead>
<tr>
<th>Glucose</th>
<th>140</th>
<th>255</th>
<th>180</th>
<th>150</th>
</tr>
</thead>
</table>

### Insulin

<table>
<thead>
<tr>
<th>Insulin</th>
<th>11 A(10+1)</th>
<th>16 A(10+6)</th>
<th>12 A(10+2)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Glargine (Lantus)</th>
<th>30</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Patient Eating TIME</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspart (Novolog)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Patient on Insulin who is Eating

<table>
<thead>
<tr>
<th>Glucose</th>
<th>140</th>
<th>255</th>
<th>180</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin</td>
<td>11 A(10+1)</td>
<td>16 A(10+6)</td>
<td>12 A(10+2)</td>
<td>30 glargine</td>
</tr>
</tbody>
</table>

Patient Eating TIME

Breakfast Lunch Dinner Bedtime

Aspart (Novolog)

10 10 10

NPH

Glargine (Lantus)

Novolog Mix 70/30

Change for next day would be increase in Breakfast and lunch Aspart

Pharmacologic Classes of Agents to Control Hyperglycemia in Type 2 Diabetes

<table>
<thead>
<tr>
<th>Class</th>
<th>Special Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiazolidinediones—e.g., rosiglitazone, pioglitazone</td>
<td>Takes 2-3 weeks to see initial effect. Effects continue for weeks or months after discontinuation of medication</td>
</tr>
<tr>
<td>Insulin secretagogues—e.g., sulfonylureas (glyburide, glipizide); repaglinide</td>
<td>Keep in mind the metabolic t½ of each drug. High risk for hypoglycemia</td>
</tr>
<tr>
<td>Biguanides—e.g., metformin</td>
<td>Withhold in conditions predisposing to renal insufficiency and/or hypoxia</td>
</tr>
<tr>
<td>Alpha-glucosidase inhibitors—e.g., acarbose &amp; miglitol</td>
<td>In case of hypoglycemia (due to sulfonylurea or insulin treatment) Glucose (dextrose) must be administered Sucrose and complex carbohydrates should not be administered</td>
</tr>
</tbody>
</table>
Pharmacologic Classes of Agents to Control Hyperglycemia in Type 2 Diabetes

<table>
<thead>
<tr>
<th>Class</th>
<th>Special Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDP 4 Inhibitor</td>
<td>Minimal Data. Low risk of hypoglycemia</td>
</tr>
<tr>
<td>GLP-1 Agonist</td>
<td>Minimal Data. GI side effects, delayed gastric emptying. Low risk of hypoglycemia</td>
</tr>
<tr>
<td>SGLT-2 Inhibitor</td>
<td>No Data. Risk of dehydration, urinary and yeast infections</td>
</tr>
<tr>
<td>Other:</td>
<td>No Data.</td>
</tr>
<tr>
<td>Colesevelam</td>
<td>GI side effects</td>
</tr>
<tr>
<td>Dopamine Agonist</td>
<td>Colesvelam: binds medications</td>
</tr>
</tbody>
</table>

Safety and Efficacy of Sitagliptin Therapy for the Inpatient Management of General Medicine and Surgery Patients With Type 2 Diabetes: A pilot, randomized, controlled study.

Diabetes Care. 2013 Jul 22. [Epub ahead of print]
### Patient on Diet or Oral Agents who is Eating

Depending on which oral agents – may or may not be continuing - - - -

### Patient on Diet alone or Oral Agents who is Eating

- **Day 1** – Use Correctional dosing only
- Base on BMI, anticipated sensitivity
Patient on Diet alone or Oral Agents who is Eating

Glucose  140  255  180  190
Insulin  1 A(0+1)  6 A(0+6)  2 A(+2)
0 glargine

A. BASAL AND NUTRITION INSULIN DOSE (IN UNITS):
- Check blood glucose before meal, bedtime and 2am.
- If patient becomes NPO HOLD nutritional dose of Aspart and give correctional dose of Aspart if BG >130 mg/dl
- If patient is NPO >4 hours call MD for IV Dextrose order

B. Meal Time CORRECTIONAL Insulin with ASPART. Check box to choose scale. Add or subtract from nutritional dose of aspart

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>Sensitive</th>
<th>Average</th>
<th>Resistant</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>70-100 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>101-150 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>201-250 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>251-300 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>301-350 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>351-400 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Over 400 mg/dl</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- Treat for hypoglycemia per protocol (see order #3). Once BG ≥100 mg/dl, give Aspart with following change when patient eats.
- 70-100 mg/dl: give 2 units less
- 101-150 mg/dl: give 2 units less
- 151-200 mg/dl: give 3 units less
- 201-250 mg/dl: give 4 units less
- 251-300 mg/dl: give 5 units less
- 301-350 mg/dl: give 6 units less
- Over 350 mg/dl: give 6 units less

Change for next day:
- FBS >130 so start basal insulin at .1 to .3 U/kg
- Preprandial >130 so start premeal insulin

Patient Scheduled for NPO Procedure

Patient is scheduled for a CT scan and is NPO tomorrow morning. Glucose at what would be breakfast time is 240. Orders are as follows. What should be done with the insulin?
Glucose 240
Insulin 6A(0+6)
65 glargine

B. Meal Time CORRECTIONAL Insulin with ASPART. Check box to choose scale. Add or subtract from nutritional dose of aspart

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>Sensitive (BMI less than 25 and/or &lt;50 units per day)</th>
<th>Average (BMI 25-30 and/or 50-90 units per day)</th>
<th>Resistant (BMI &gt;30 and/or &gt;90 units per day)</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td></td>
</tr>
<tr>
<td>70-100 mg/dl</td>
<td>2 units less</td>
<td>2 units less</td>
<td>3 units less</td>
<td></td>
</tr>
<tr>
<td>101-130 mg/dl</td>
<td>Give nutritional dose of Aspart as in 0.1A above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>131-150 mg/dl</td>
<td>10 units</td>
<td>11 units</td>
<td>12 units</td>
<td></td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>3 units</td>
<td>3 units</td>
<td>3 units</td>
<td></td>
</tr>
<tr>
<td>201-250 mg/dl</td>
<td>4 units</td>
<td>4 units</td>
<td>4 units</td>
<td></td>
</tr>
<tr>
<td>251-300 mg/dl</td>
<td>5 units</td>
<td>6 units</td>
<td>6 units</td>
<td></td>
</tr>
<tr>
<td>301-400 mg/dl</td>
<td>6 units</td>
<td>8 units</td>
<td>8 units</td>
<td></td>
</tr>
<tr>
<td>Over 400 mg/dl</td>
<td>9 units</td>
<td>12 units</td>
<td>12 units</td>
<td></td>
</tr>
</tbody>
</table>

A. BASAL AND NUTRITION INSULIN DOSE (IN UNITS):

- Check blood glucose before meal, bedtime, and 2 am.
- If patient becomes NPO HOLD nutritional dose of Aspart and give correctional dose of Aspart if BG >130 mg/dl.
- If patient is NPO >4 hours call MD for IV Dextrose order.

Patient Eating TIME

Breakfast | Lunch | Dinner | Bedtime

Aspart (Novolog) Nutritional Dose

- 21
- 14
- 19
- 65

Method 1:

Take the last 24 hour insulin infusion

Basal: 24 hour total/2
Aspart: 24 hour total/10 given q4h

Example: 2 units per hour – 48U

Basal: 48/2=24U glargine
Aspart: 48/10=4.8
(5 U aspart q4h)

Method 2:

Similar to Method 1 – just using a higher proportion of basal insulin

Method 3:

If no IV – just use 1 unit per 6-10g CHO to start and calculate as per #1

Tube Feeds
### Tube Feeds

<table>
<thead>
<tr>
<th>Glucose</th>
<th>140</th>
<th>255</th>
<th>180</th>
<th>260</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin</td>
<td>6 A(5+1)</td>
<td>11 A(5+6)</td>
<td>7 A(5+2)</td>
<td>11 A(5+6)</td>
</tr>
</tbody>
</table>

24 glargine

<table>
<thead>
<tr>
<th>Type of Insulin</th>
<th>Nutritional Dose</th>
<th>Injection Sites</th>
<th>Glargine (Lantus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutritional Dose</td>
<td>Sensitive BMI less than 25 and/or &lt;50 units per day</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td>Average BMI 25-30 and/or 50-90 units per day</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resistant BMI &gt;30 and/or &gt;90 units per day</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Change for next day would be increase in glargine</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### B. Meal Time CORRECTIONAL Insulin with ASPART. Check box to choose scale. Add or subtract from nutritional dose of aspart

<table>
<thead>
<tr>
<th>Blood Glucose Range</th>
<th>Sensitive BMI less than 25 and/or &lt;50 units per day</th>
<th>Average BMI 25-30 and/or 50-90 units per day</th>
<th>Resistant BMI &gt;30 and/or &gt;90 units per day</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;130 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>101-130 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>&gt;100 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>70-100 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>51-70 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>41-50 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
<tr>
<td>&lt;50 mg/dl</td>
<td>2 units less</td>
<td>3 units less</td>
<td>4 units less</td>
<td>units less</td>
</tr>
</tbody>
</table>

### Cases: FLAC

Patient FLAC is a 42 year old male who has a history of liver transplant. He is admitted with for knee surgery. Medications are Prednisone, 5 mg/day, stable immunosuppressive regimen, amlodipine, dapsone.

Glucoses were high post transplant 2 years ago. HbA1c since then averages 4.9 (last check 2 weeks ago)

No home monitoring.

You are called in as a "medical consultant" and happen to see the glucose preop was 254 (also 2 weeks ago). Should you be concerned and what should you do?
**Cases: FLAC**

**HbA1c:**
formed by non-enzymatic condensation of glucose with the N-terminal valine residue of the β chains of hemoglobin., HbA1c reflects the glucose level an erythrocyte has been exposed to during its lifespan and is a measure of glycemic control over the last 3 months with the immediately preceding 30 days contributing 50% to the HbA1c.

**Dapsone:**
Three mechanism for false HbA1c:
1. Can induce hemolysis
2. Interference with assay
3. Hemolytic independent reduction in erythrocyte survival


**Glucocorticoids and Diabetes**

Glucose

Liver

Increased glucose production

Pancreas

Impaired insulin secretion

Insulin resistance

Peripheral Tissues (Muscle)

postreceptor defect
Glucocorticoids and Diabetes:

- Breakfast
- Lunch
- Dinner
- Bedtime
- Breakfast

Glucose

Typical sliding scale insulin
Glucocorticoids and Diabetes:

- Typical sliding scale insulin
- Revved Up sliding scale insulin

Glucose levels over time:
- Breakfast
- Lunch
- Dinner
- Bedtime
- Breakfast
Glucocorticoids and Diabetes:

- Revved Up sliding scale insulin

Glucocorticoids and Diabetes:

- NPH and Regular
Glucocorticoids and Diabetes:

![Graph showing glucose levels at different times of the day, with increasing NPH and Regular injections]
Glucocorticoids and Diabetes:

Insulin Requirements:
- Often 0.5 to >1 unit/kg
- Dosing distribution
  - 25% basal
  - 25% at each meal

Need Daily Adjustments

Adjustments on decrease:
- Generally effects decrease about 2 days after DC of the glucocorticoids.
- No algorithm has been really been tested

With “pulses” ---- remember past pulses!!
Case: MOD

Patient MOD is a 50 year old female admitted for influenza. She has been on metformin, glyburide, pioglitazone and sitagliptin at home for her type 2 diabetes (which has been described as in good control). You have just returned from this course. The oral medications are stopped and basal/bolus insulin is started.

You round the next day and find out gluoses are totally crazy, from 128 in the morning, to 294 before lunch and then 36 mid afternoon.

Case: MOD

You investigate and find:

At 7am: Glucose 128. patient did not eat and no insulin given.


At 2:30 you are called as the glucose is 38 mg/dl.
Case: MOD

You notice a poster on the wall of the nursing station all about the new “meals on demand.”

What should you do?
11/12/2014

Background

- 11 Long started the on-demand meal system ~ 2 yrs ago
- Caloric intake has improved by 20%!
- Non-standardized times problematic for RNs:
  - Timing of insulin
  - Timing of Blood Glucose Point of Care Test
  - Documentation
- Patient Trigger
Module!

![SQ Insulin Decision Tree](image)

**Insulin Ordered**

- Check BG and give insulin according to MAR times. *No tray necessary for insulin to be given*

**Only Correctional**

- If pt skips meal or NPO

**Correctional Nutritional Snack**

- If pt plans to eat within 1 hr

- Check BG and give ordered correctional per standard due time. DO NOT give nutritional

- Plan to give correctional and nutritional insulin together when pt arrives

**Meal arrives > 3 hrs minus last BG, POCT**

- Give nutritional dose. DO NOT recheck BG

**Meal arrives 1-3 hrs**

- From last BG POCT

- Use check BG and give correctional + nutritional per order

**Meal arrives 1-3 hrs**

- From last MAR due time

Tips

1. All BG checks should be at least 3 hrs from previous insulin admin including bedtime.
2. If pt cannot “wait” to eat before POCT, food tray can be delivered to unit coordinator.
3. Check out nursing procedure: insulin Admin with room Service Meal Delivery for more info.
Results

- Post-Data

**Patient Insulin Administration Chart Audits**

- Blood Glucose Checked per Guidelines
  - Pre-Intervention: 79%
  - Post-Intervention: 97%

- Correctional Insulin Given if Needed
  - Pre-Intervention: 81%
  - Post-Intervention: 92%

- Nutritional Insulin documented separately
  - Pre-Intervention: 1%
  - Post-Intervention: 2%

Acknowledgements

11 Long RNs
Melissa Lee, MS, RN, CNS-BC
Amy Nichols, RN EdD
Heidemarie Windham, PharmD, CDE
Flo Agudelo, BSN, RN
Cami Lenett, RN, MS, OCN
Gabrielle Perez, RN
Therapeutic Inertia

- Physician Education
- Daily High Glucose Report
  - Nurse to check in on patients with very high glucoses
- Diabetes team for patients with high glucoses
  - Physician
  - Nurse
  - Pharmacist
- Diabetes Team for All Patients
  - Physician
  - Nurse
  - Pharmacist

UCSF Intervention limitations

- Physician Education
  - Still not all residents get training
  - Residents not taking care of patients
  - Hospitalists (turnover)

- Nursing
  - NPs managing patients
Big Brother

● Daily Reports:
  – 2 or more glucoses > 225
  – Glucose < 60
  – On insulin pump
  – Dx type 1 DM
How to communicate with teams

- Impossible to figure out who is actually taking care of patient
- Pager – to tell them to read email (but which pager)
- Email – no one actually reads emails
- Sticky notes
- Endocrine notes (people don’t actually read other notes)
Daily Glucose Checks

- IV insulin  q1h (24/d)
- NPO/TPN/Enteral  q4h (6/d)
- Patient eating
  - Premeal
  - Bedtime/2am
  -(5/d)
### Typical ICU Patient s/p Liver Transplant

#### Laboratory Values

<table>
<thead>
<tr>
<th>Date</th>
<th>1st ML</th>
<th>6th ML</th>
<th>11th ML</th>
<th>16th ML</th>
<th>21st ML</th>
<th>26th ML</th>
<th>31st ML</th>
<th>6th ML</th>
<th>11th ML</th>
<th>16th ML</th>
<th>21st ML</th>
<th>26th ML</th>
<th>31st ML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>162.4</td>
<td>176.2</td>
<td>186.2</td>
<td>194.2</td>
<td>188.2</td>
<td>190.2</td>
<td>182.2</td>
<td>174.2</td>
<td>180.2</td>
<td>186.2</td>
<td>188.2</td>
<td>190.2</td>
<td>182.2</td>
</tr>
<tr>
<td>Wed</td>
<td>162.2</td>
<td>176.2</td>
<td>186.2</td>
<td>194.2</td>
<td>188.2</td>
<td>190.2</td>
<td>182.2</td>
<td>174.2</td>
<td>180.2</td>
<td>186.2</td>
<td>188.2</td>
<td>190.2</td>
<td>182.2</td>
</tr>
</tbody>
</table>

#### Laboratory Monitoring

- *Glucose (mg/dL)*
- *Hematocrit (%)*
- *Platelet Count (k/ul)*

#### Medications

- *Narcotic: Fentanyl* 100 mcg/h
- *Antibiotics: Cefepime* 500 mg 12-hourly
- *Anticoagulant: Warfarin* target INR 2-3

#### Other Observations

- *Temperature*: 98.6°F
- *Weight*: 170 lbs
GLUCOSE MANAGEMENT CONSULT NOTE

We are now receiving daily reports showing patients who have had ≥2 glucose levels in the past 24 hours >225 and or <60 and or on a pump and or type 1 diabetes. Your patient [ REDACTED ] shows up on the report.

<table>
<thead>
<tr>
<th>Date</th>
<th>Glucose Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/01/13</td>
<td>9147</td>
</tr>
<tr>
<td>18/01/13</td>
<td>1408</td>
</tr>
<tr>
<td>20/01/13</td>
<td>1549</td>
</tr>
<tr>
<td>30/01/13</td>
<td>1368</td>
</tr>
<tr>
<td>01/02/13</td>
<td>1654</td>
</tr>
<tr>
<td>10/02/13</td>
<td>1577</td>
</tr>
</tbody>
</table>

Glucose Note Types 30420090

These suggestions are based on the recent glucose levels and the insulin orders currently found in APEX. Your clinical judgment is always required when ordering insulin and there may be clinical issues or changing patient status, not currently reflected in the chart that would call for insulin order changes other than suggested above.

Please note that formal consultation is always available.

If you need to brush up on these concepts training is available at http://rushakoff.com/newcourses/nextpage.php?coursed=47

Robert J. Rushakoff, MD
10/9/2013
We are now receiving daily reports showing patients who have had ≥2 glucose levels in the past 24 hours ≥225 and or <60 and or on a pump and or type 1 diabetes. Your patient shows up on the report.

In the last 36 hours of POCT glucose(s), as shown above, has had elevated glucose levels and is currently only receiving basal insulin (glargine) and sliding scale. Impaired glucose metabolism. Just using basal insulin can result in trying to cover the patient's nutritional insulin requirements with too much basal insulin, placing the patient at risk for hypoglycemia. Given the patient's glucose levels and insulin received, we suggest that patient should be on both basal and premixed insulin.

Specific Suggestions:

Use Order Set: UCSF IP ADULT SQ INSULIN (PRE MEAL) STANDARD
1. Basal insulin: Start 18 units glargine insulin (Tide-Tempo) 0.50 units 30420692
2. Premixed nutritional insulin: Use the Premixed Option 30420692 option
   A. Breakfast: *** units
   B. Lunch: *** units
   C. Dinner: *** units
3. If you are unsure if the patient will be eating, you may consider using (after eating order set: UCSF IP ADULT SQ INSULIN (POST MEAL) SPECIAL) where the nutritional insulin dose will be adjusted for what the patient ate. Use the same orders as above.

These suggestions are based on the recent glucose levels and the insulin orders currently found in APEX. Your clinical judgment is always required when ordering insulin and there may be clinical issues or changing patient status, not currently reflected in the chart that would call for insulin order changes other than.
Figure 4: Number of Patients Per Day with 2 or more glucose ≥ 225

Average number of patients per day with 2 or more glucose ≥ 225 from a 10 day audit from each of the following months. (+/- SE)
10/12: Baseline
10/13: Glucose Service Month 6
5/13: Glucose Service Month 1
5/14: Glucose Service Month 12

Figure 5: % Of Patients In Each Glucose Range Among Patients On SQ Insulin Premeal Protocol July 2012-March 2014

Glucose Management Service Active
“I know that for my interns, the feedback really drives their own improvements because they want to avoid getting a "Rushakoff note" in the chart the next morning. And it works as a perfect "just-in-time" teaching mechanism to inform appropriate responses to high blood sugars for inpatients.”
**IV insulin**

- **Nursing perspective**
  - IV insulin protocols are labor intensive
  - 2-3 hours per day of direct nursing time is required for hourly glucose monitoring and IV insulin adjustments
  - Insulin infusion protocols can be viewed as too complex by even experienced nurses

---

**Simple Subcutaneous Insulin Algorithm for Management of the NPO Hyperglycemic Patient in the ICU**

**Check BG q4hr (06, 10, 14, 18, 22, 02). Adjust Insulin Aspart dose q4hr as follows:**

<table>
<thead>
<tr>
<th>BG</th>
<th>Instruction</th>
</tr>
</thead>
</table>
| <80 mg/dL | a. Do not administer insulin.  
|       | b. Treat for hypoglycemia per protocol (see #7 Below).  
|       | c. Continue to check glucose q4 hours  
|       | d. When glucose is >120 mg/dL, give insulin at 50% of dose administered prior to glucose being <80 mg/dL, then restart protocol |
| 80-120 | *Give same amount of insulin as given 4 hours earlier less 2 units |
| 121-180| *Give same amount of insulin as given 4 hours earlier |
| 181-240| *Give same amount of insulin as given 4 hours earlier plus 2 units |
| >240  | a. Give same amount of insulin as given 4 hours earlier plus 2 units.  
|       | b. Give additional 4 units X 1 NOW (may be given as single injection combined with scheduled dose). Do not include this extra 4 units in determination of next insulin dose. |
SQ Insulin Algorithm Results: Average of all Patients

SQ Insulin Algorithm Results: Individual Results
### Insulin Dose *

<table>
<thead>
<tr>
<th>Days on IV or SQ Insulin Protocol</th>
<th>SQ</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

### Glucose (mg/dl)

<table>
<thead>
<tr>
<th>Days on SQ Insulin Protocol</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients on Protocol</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>
Hyperglycemia in Hospitalized Patients

Transition from Home to Hospital

ucs夫.logicnets.com

Anesthesia
Jan Hirsch, MD
David Robinowitz, MD
Kathryn Rouine-Rapp, MD

Pharmacy
Heidemarie Windham, PharmD

Endocrinology
Robert J. Rushakoff, MD
When will the Surgery/Procedure be taking place?

Click on one of the circles below for your response. (For this question and for all questions where only a single choice is allowed, as soon as you click on the circle of your choice, the next screen will appear.)

- SURGERY/PROCEDURE IS NOT TODAY. This is a preoperative visit or evaluation AT LEAST ONE DAY BEFORE the scheduled surgery or procedure. Based on the information the patient provides to you, specific instructions for the patient will be generated.
- SURGERY/PROCEDURE IS TODAY. This is a preoperative evaluation for a patient who has checked into your facility and is scheduled for a procedure TODAY. Based on the information you provide, specific guidelines for final preparation and monitoring of the patient will be generated to assist you in managing their diabetes medications and glucose levels before the procedure begins.

Patient Diabetes Medications

Select ALL of the types of medications that the patient is currently using for their glucose control.

(check one or more and then "submit"):  
- Oral Agent  
- Taking Insulin  
- Taking Injectable (not insulin: exenatide-Byetta; liraglutide-Victoza; pramlintide-Symlin)

SUBMIT
Select **ALL** of the types of oral medications that the patient is currently using for their glucose control.

(check one or more and then "submit")

- **Sulfonylureas**
  - glimepiride-AMaryl
  - glibizide-Glucotrol (and XL)
  - glyburide-Micronase, Glynase, Diabeta
  - chlorpropamide
  - tolazamide
  - tolvaptamide

- **Meglitinides**
  - repaglinide
  - nateglinide

- **Biguanide**
  - metformin - generic, generic XL
  - glucophage
  - glucophage XL
  - forxmet
  - glumetza
  - riomet

- Thiazolidinediones
  - pioglitazone-Actos
  - rosiglitazone-Avandia

- alpha-Glucosidase Inhibitors
  - acarbose-Precose/Glucobay
  - miglitol-Glyset

- Dopamine Agonist
  - bromocriptine-Cycloset, Parlodel

- Bile Acid Sequestrant
  - colesvelam-WelChol

- DPP-4 Inhibitor
  - sitagliptin-Januvia
  - saxagliptin-Onglyza

- Combination Pill
  - glyburide/metformin-Glucoavnce
  - glibizide/metformin-Metaglip
  - glimepiride/pioglitazone-Duetact
  - glimepiride/rosiglitazone-Avandaryl
  - pioglitazone/metformin-ACTOSPlusMet
  - repaglinide/metformin-BrandMet

---

Select **ALL** the types of insulin that the patient is currently injecting.

(If patient is using an insulin pump, just choose pump. For patients on insulin by injection, choose one or more of the types of insulin and then "submit")

- **Pump (using short or rapid acting insulin)**
- Basal Insulin (glargine-Lantus; detemir-Levemir)
- Intermediate Insulin (NPH)
- Rapid and Short Acting Insulin (aspart-Novolog; lispro-Humalog; glulisine-Apidra; regular)
- Premixed Insulins (70/30, 75/25, 50/50)
- Regular US00 Insulin (concentrated insulin)

**Submit**
Issues at Discharge

- Patient new to diabetes
- Patient new to insulin or other medications
- Not metabolically stable (eg, steroid taper), unclear what any requirement will be
- Oral agents, incretins - when, how, why
- Changing medications (TPN, etc.) on the day of discharge
- Inability to perform self management
- Who follows patient
- Communication of inpatient care plan to outpatient providers
- Short-term and long-term goals
Cases: DCP and DCNP

Patient DCP is a 57 year old female. s/p total pancreatectomy. On glargine/aspart (basal/bolus) in hospital. Well trained by expert nurse educator. Glucose control great at time of DC to home.

Few days after DC to home, you get a call, patient in ER with mild DKA. They gave fluid and insulin and sent patient home. Next day, patient again in ER with same finding.
Patient DCNP is a 64 year old female. s/p start of insulin at recent hospital stay. On glargine/aspart (basal/bolus) in hospital. Well trained by expert nurse educator. Glucose control great at time of DC to home.

Few days after DC to home, you get a call. You are told patient has consistently had glucose in the 2-300 mg/dl range.

What do you do?
1. Increase the glargine and/or aspart
2. Review the patient’s diet
3. Ask “are there any problems giving the insulin?”
4. Nothing, it is the problem for the outpatient providers to figure out.
5. None of the above
PEOPLE CHANGING INPATIENT DM MANAGEMENT AT UCSF

- **Physicians**
  - Robert Rushakoff
  - Umesh Masharani
  - Melissa Weinberg
  - Sarah Kim
  - Aaron Neinstein
  - Bonnie Kimmel
  - Saleh Adi
  - Stephen Gitelman
  - Jan Hirsch
  - Kathryn Rouine-Rapp
  - David Robinowitz
  - Michael Hwa
  - Heather Nye
  - Steve Pantilat

- **Nurses**
  - Mary Sullivan
  - Pauline Chin
  - Marlene Bedrich
  - Craig Johnson
  - Molly Killion
  - Jeanne Buchanan
  - Noraliza Salazar
  - Lynn Dow
  - Byanga Robinson

- **Pharmacists**
  - Heidemarie Windham
  - Lisa Kroon
  - Kethen So
  - Thomas Bookwalter
  - Anna Seto
  - Yali Brennan

- **Administration**
  - Rosanne Rappazini
  - Jennifer Pacholuk
  - Joy Pao
  - Janice Hull

- **Dietary**
  - Marian Devereaux
  - Ami Bhow

---

Community Hospital Training

**Annenberg Project**

Physicians

- Robert J. Rushakoff, MD
  Director Inpatient Diabetes, UCSF

- Cheryl W. O’Malley, MD
  Program Director, Internal Medicine Banner Good Samaritan Medical, Phoenix, Arizona

- Kendall M. Rogers, MD
  Chief, Hospital Medicine University of New Mexico Health Sciences Center Albuquerque, New Mexico

- Archana Sadhu, MD
  Director, Inpatient Diabetes Program, The Methodist Hospital System Houston, Texas

Diabetes Educators

- Carol Manchester, MSN, ACNS, BC-ADM, CDE
  University of Minnesota Medical Center, Minneapolis, Minnesota

- Jane Jeffrie Seley, DNP, MPH, BC-ADM, CDE
  New York Presbyterian/Weill Cornell Medical Center

- Mary M. Sullivan, RN, DNP, ANP-BC, CDE
  University of California, San Francisco

- Eric D. Peterson, EdM, FACME
  Annenberg Center for Health Sciences at Eisenhower
Faculty team visits each site
  • 1 physician (inpatient endocrinologist or hospitalist)
  • 1 nurse with inpatient glycemic control experience

Team Meeting
  • Review experience, goals, barriers
  • Refine the team project
  • who they need to involve
  • Data collection to characterize their current performance
  • Common barriers that they are likely to face and strategies that have been used by other institutions to overcome them
  • Implementation and measurement that they may want to consider to evaluate both process and outcome

Presentation to other stakeholder groups
  • Physician or nursing staff forums
Web Conferences

- 3 Web conferences planned
  - #1 Sites share their project plans
  - #2 Sites present interim progress and challenges
  - #3 Sites present data generated from their project
- Primarily intended as a tactic to keep sites “on task” and to facilitate interaction between sites

Annenberg Center Diabetes Project -Hospital B-

- Community, non-teaching; No Endocrinology
- Lots of forms – main was self adjusting SS
- Many MD groups, hospitalist group
- No education, Meal timing
Lots of forms – main was self adjusting SS
  - SS form gone; BB mainly used (CHO based postmeal for meals on demand)

Many MD groups, hospitalist group
  - Hospitalist contract dispute

No education
  - Case studies – CDs, in person for specific populations

Meals
  - Refreshment centers closed
  - Still get meals on demand

CDE Involvement
  - Assist with insulin orders
  - Call MDs for consistently high numbers