Management of Diabetes in the Hospitalized Patient: 2013

Irl B. Hirsch, M.D.
Professor of Medicine
University of Washington School of Medicine
Disclosures

• Research/Grants: Sanofi, Halozyme
• Consultant: Abbott, Roche
Welcome To My World: ARS Case 1

It is July 1 and you are attending on the endocrine service with a new fellow. The fellow is called for her first consult, a 55 year-old woman with T2DM (at home receiving glargine/lispro at 40 u/day) admitted overnight for a hepatic embolization for hepatocellular carcinoma. Prior to the procedure and per protocol she received 10 mg of IV dexamethasone.

She is started on an insulin drip with good glucose control in the 140-160 range. However, the nurse requests an endocrine consult as the patient is *ready to go home now* (her family has the car waiting in the front of the hospital for the 4 hour drive to Eastern Washington). The problem: the patient is now receiving 35 units/hour of insulin to control her BG.
What Would You Do Now?

A) Double the home dose of insulin
B) Begin sliding scale regular insulin
C) Keep her in the hospital and continue the IV infusion;
D) Stop the infusion, send her home with hourly glucose tests but no mealtime insulin until she speaks to the fellow on-call
E) Send the fellow to begin her fellowship at the U of Oregon
Hyperglycemia is common in patients with and without diabetes.

Number (in Thousands) of Hospital Discharges with Diabetes as Any-Listed Diagnosis, United States, 1988–2009

93% increase

Hyperglycemia is Linked to Mortality Regardless of Diabetes Status

- Euglycemic patients without diabetes
- Euglycemic patients with diabetes
- Hyperglycemic patients with diabetes
- Hyperglycemic patients without diabetes

*≥200 mg/dL

180-Day Mortality in Patients Admitted for MI

Mortality in Inpatients with “New Hyperglycemia”

Big Picture

Why is euglycemia not even recommended for inpatients (either ICU or non-ICU)?
The Problem

NICE-SUGAR
CONCLUSION OF AUTHORS

“On the basis of our results, we do not recommend use of the lower target in critically ill adults”

NEJM 360:1283, 2009
Tight Glycemic Control in Critically Ill Adults
A Meta-analysis of 26 Randomized Controlled Trials
(13,567 patients)

All-cause Mortality

But in These Studies, Consider “Standard Control”!

- Is control in the hospital (esp. the ICU) as good as the control groups in your hospital in these studies?
# Glucose Levels Achieved

**(mg/dL; mean ± SD)**

<table>
<thead>
<tr>
<th>Trial</th>
<th>Intensive</th>
<th>Standard</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIGAMI I (24h) (1)</td>
<td>173 ± 59</td>
<td>211 ± 74</td>
<td>38</td>
</tr>
<tr>
<td>Leuven I (2)</td>
<td>103 ± 19</td>
<td>153 ± 33</td>
<td>50</td>
</tr>
<tr>
<td>Leuven II (3)</td>
<td>111 ± 29</td>
<td>153 ± 31</td>
<td>42</td>
</tr>
<tr>
<td>Krinsley* (4)</td>
<td>119 ± 49</td>
<td>154 ± 87</td>
<td>35</td>
</tr>
<tr>
<td>VISEP (5)</td>
<td>112 ± 18</td>
<td>151 ± 33</td>
<td>39</td>
</tr>
<tr>
<td>De La Rosa** (6)</td>
<td>117 (110-140)</td>
<td>148 (122-180)</td>
<td>31</td>
</tr>
<tr>
<td>NICE-SUGAR (7)</td>
<td>115 ± 18</td>
<td>144 ± 23</td>
<td>29</td>
</tr>
</tbody>
</table>

* Not RCT

** Median (interquartile range)

1. JACC 26:57-65, 1995
Bottom Line

• NICE-SUGAR (Normoglycemia in Intensive Care Evaluation and Survival Using Glucose Algorithm Regulation) and all RCT’s except the Van den Berghe SICU Study (NEJM, 2001) have not shown intensive insulin therapy to improve major outcomes, including mortality in ICU patients.

• Still, all epidemiological data consistently shows hyperglycemia associated with increased mortality.
The Real Problem
HYPOglycemia does not get the respect it deserves!
Why New Respect for Hypoglycemia?

- Acute inflammatory activation- “metabolic memory”?
- Prolonged QT-interval leading to more malignant arrhythmias
- Endothelial Dysfunction
- CNS damage
Hypoglycemia: Summary

- We are understanding more of the mechanistic concerns with hypoglycemia.
- The role of hypoglycemia on outcomes requires further study and likely also varies based on the specific patient population.

Still, we would all agree: hypoglycemia is dangerous!
ADA/AACE Target Glucose Level in ICU Patients

- ICU setting:
  - Starting threshold of no higher than 180 mg/dl
  - Once IV insulin is started, the glucose level should be maintained between 140 and 180 mg/dl
  - Lower glucose targets (110-140 mg/dl) may be appropriate in selected patients
  - Targets <110 mg/dL or >180 mg/dl are not recommended
One Author’s Opinion

“In many hospitals, maintaining blood glucose levels similar to those in the conventional-control group of the NICE-SUGAR population is safe and similar to other recommendations (140-180 mg/dL)...the use of more conservative glucose targets is unacceptable and older, nonchalant attitudes need to be abandoned. For surgical patients, especially those who have undergone cardiac procedures, hospitals that can safely achieve lower targets should do so. Continued improvements in technology for continuous glucose monitoring should both answer the questions raised by NICE-SUGAR and expand opportunities for better control”

“We have no evidence to keep blood glucose levels in the hospital above 200 mg/dL”
Hyperglycemia Rx for the ICU Patient

UWMC Insulin Infusion Protocol (Not For DKA/HHS or Pediatrics)

- CONSULT ENDOCRINE SERVICE FOR:
  - Acute Care patients on insulin infusion receiving oral nutrition or intermittent tube feeding

GOAL Blood Glucose (BG) RANGE:

- ACUTE CARE OR ICU: 100-180 mg/dL initiate when ordered
- ICU ONLY: 100-140 mg/dL initiate when BG > 140 × 2

- Discontinue all previous insulin orders.
- Insulin Infusion: 100 units insulin / 100 mL NS given IV infusion, at:
  - Algorithm 1: Start here for most patients.
  - Algorithm 2: Start here if S/P CABG surgery, solid organ transplant, receiving glucocorticoids, or patient receiving > 80 units/day of insulin as an outpatient.
- NO PATIENT STARTS AT ALGORITHM 3 OR 4.
Monitoring

Patient Monitoring:
- Check BG every 1 hour until it is within goal range for 4 hours. Then decrease BG checks to every 2 hours. ALWAYS resume hourly checks if BG exits goal range.
- Hourly monitoring may be indicated for critically ill patients or patients having medical or surgical procedures even if they have stable BG.

Notify the Provider:
- For any BG increase >100 mg/dL from a stable baseline
- For 2 consecutive BG decreases of >100 mg/dL
- For any hypoglycemia which results in loss of consciousness OR does not resolve within 20 min of implementing the hypoglycemia protocol below
Insulin Infusion Algorithm Decision Tree

Blood Glucose in Goal Range?

- Yes
  - Was decrease more than 30 mg/dL OR previous BG below goal range?
    - Yes
      - Move LEFT one algorithm and adjust rate to match BG range
    - No
      - Adjust rate hourly to match BG range in current algorithm until BG is in goal range X 4 hrs
      - Once within goal range for 4 hrs, check BG q2hr. Do NOT adjust rate unless BG < 110 or > 180

- No
  - Above Goal Range
    - BG decreased > 75
      - Move LEFT one algorithm and adjust rate to match BG range
      - Recheck BG in 20-30 minutes if BG decreased >100 mg/dL
    - BG decreased 50-75
      - Adjust rate to match BG range in current algorithm
    - BG increased by any amt. or decreased <50
      - Move RIGHT one algorithm and adjust rate to match BG range

- Below Goal Range and Hypoglycemia
  - TURN OFF insulin infusion
  - For BG 70-99 No dextrose
  - For BG 50-69 Give 25mL (½ amp) 50% dextrose
  - For BG < 50 Give 50mL (1 amp) 50% dextrose
  - Recheck BG in 20-30 min.
  - When BG has increased to goal range, move LEFT one algorithm. Adjust rate to match BG range

If TPN/Enteral nutrition is stopped or significantly reduced, decrease insulin infusion rate by moving LEFT one algorithm. Then, use algorithm table & instructions to determine subsequent rate changes AND check BG every 1 hour x 4 hours.
# Insulin Algorithms

<table>
<thead>
<tr>
<th>Algorithm 1</th>
<th>Algorithm 2</th>
<th>Algorithm 3</th>
<th>Algorithm 4</th>
</tr>
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<tbody>
<tr>
<td>BG</td>
<td>Unit/hr</td>
<td>BG</td>
<td>Units/hr</td>
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<tr>
<td>100-120</td>
<td>0.5</td>
<td>100-120</td>
<td>1</td>
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<tr>
<td>121-140</td>
<td>0.8</td>
<td>121-140</td>
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<tr>
<td>141-160</td>
<td>1.2</td>
<td>141-160</td>
<td>2</td>
</tr>
<tr>
<td>161-180</td>
<td>1.5</td>
<td>161-180</td>
<td>2.5</td>
</tr>
<tr>
<td>181-210</td>
<td>2</td>
<td>181-210</td>
<td>3</td>
</tr>
<tr>
<td>211-240</td>
<td>2.5</td>
<td>211-240</td>
<td>4</td>
</tr>
<tr>
<td>241-270</td>
<td>3</td>
<td>241-270</td>
<td>5</td>
</tr>
<tr>
<td>271-300</td>
<td>3.5</td>
<td>271-300</td>
<td>6</td>
</tr>
<tr>
<td>301-330</td>
<td>4</td>
<td>301-330</td>
<td>6.5</td>
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<tr>
<td>331-360</td>
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<tr>
<td>&gt;360</td>
<td>5</td>
<td>&gt;360</td>
<td>8.5</td>
</tr>
</tbody>
</table>

<70 = Hypoglycemia  See front of form for treatment

70-99: Off x 20-30 minutes & recheck BG

If NOT achieving glycemic control with Algo 4 X

*3 consecutive hours

Consider High Dose Infusion Protocol (UH 2813)
# High-Dose Infusion

<table>
<thead>
<tr>
<th>Algorithm 5</th>
<th>Algorithm 6</th>
<th>Algorithm 7</th>
<th>Algorithm 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG</td>
<td>Unit/hr</td>
<td>BG</td>
<td>Unit/hr</td>
</tr>
</tbody>
</table>

- **Algorithm 5**
  - BG = 100-120: 3 Unit/hr
  - BG = 121-140: 5 Unit/hr
  - BG = 141-160: 7 Unit/hr
  - BG = 161-180: 9 Unit/hr
  - BG = 181-210: 11 Unit/hr
  - BG = 211-240: 14 Unit/hr
  - BG = 241-270: 17 Unit/hr
  - BG = 271-300: 20 Unit/hr
  - BG = 301-330: 23 Unit/hr
  - BG = 331-360: 26 Unit/hr

- **Algorithm 6**
  - BG = 100-120: 4 Unit/hr
  - BG = 121-140: 6.5 Unit/hr
  - BG = 141-160: 9 Unit/hr
  - BG = 161-180: 12 Unit/hr
  - BG = 181-210: 15 Unit/hr
  - BG = 211-240: 19 Unit/hr
  - BG = 241-270: 23 Unit/hr
  - BG = 271-300: 26 Unit/hr
  - BG = 301-330: 30 Unit/hr
  - BG = 331-360: 34 Unit/hr

- **Algorithm 7**
  - BG = 100-120: 5 Unit/hr
  - BG = 121-140: 8.5 Unit/hr
  - BG = 141-160: 12 Unit/hr
  - BG = 161-180: 15 Unit/hr
  - BG = 181-210: 19 Unit/hr
  - BG = 211-240: 23 Unit/hr
  - BG = 241-270: 28 Unit/hr
  - BG = 271-300: 33 Unit/hr
  - BG = 301-330: 38 Unit/hr
  - BG = 331-360: 42 Unit/hr

- **Algorithm 8**
  - BG = 100-120: 6 Unit/hr
  - BG = 121-140: 10 Unit/hr
  - BG = 141-160: 14 Unit/hr
  - BG = 161-180: 18 Unit/hr
  - BG = 181-210: 23 Unit/hr
  - BG = 211-240: 28 Unit/hr
  - BG = 241-270: 34 Unit/hr
  - BG = 271-300: 40 Unit/hr
  - BG = 301-330: 46 Unit/hr
  - BG = 331-360: 52 Unit/hr

- **Algorithm 4** (See Standard Insulin Infusion (UH1957))

- **General Guidelines:**
  - Patient who do not achieve desired control with Algorithm 4 for >3 hours are likely to have increase insulin resistance or high caloric intake.
  - Resume standard insulin infusion protocol if BG drops more than 100 mg/dL in one hour using Algorithm 5.
  - Patients may not receive insulin by more than one route (i.e. IV/SubQ) except at transition off IV insulin or by order of an endocrine consult team.
ARS Case 2

A 54 year-old woman without significant PMH is admitted with new atrial fibrillation and is diagnosed with hyperthyroidism with classical eye findings to suggest Graves disease. She has lost 10 pounds in the past month. Her family history is pertinent in that her father has type 1 diabetes, her mother has type 2 diabetes, and she has two siblings with Hashimoto’s thyroiditis.

Besides the Graves ophthalmopathy, PE is remarkable for a BMI of 33 kg/m², a diffusely large thyroid with bilateral thyroid bruits, and patches of vitiligo on her back and chest.

Admission lab reveals a random glucose of 175 mg/dL, normal electrolytes and a HbA1c of 6.9%. Urine shows trace ketonuria.
Besides dietary education, how would you treat her hyperglycemia in the hospital?

A) Metformin
B) A GLP-1 receptor agonist
C) Basal insulin only
D) Sliding scale insulin
E) Basal-bolus insulin
2012 Recommendations

TES, ADA, AHA, AADE, ESE, SHM

• GRADE group recommendations
  • 1 = strong recommendation
  • 2 = weak recommendation

- Very weak quality evidence
- Weak quality evidence
- Moderate quality evidence
- High quality evidence

JCEM 2012;97:16-38
2012 Recommendations: Non-Critical Care Settings

• “We recommend pre-meal targets < 140 mg/dL and random BG < 180 mg/dL for the majority of hospitalized patients with non critical illness”
  • 1 ★★★★★

• “We suggest clinical guidelines be modified according to clinical status. For patients able to maintain lower targets without hypoglycemia, a lower target range may be reasonable. For those with a terminal illness, shortened life expectancy, or at a high risk of hypoglycemia, a higher target range (< 200 mg/dL) may be reasonable”
  • 2 ★★★★★

JCEM 2012;97:16-38
2012 Recommendations:
Pharmacologic Therapy in the Hospital

• “We suggest discontinuation of oral agents and initiation of insulin therapy for the majority of patients with type 2 diabetes at the time of hospital admission”
  • 2 ☺☺☺☺

• “We recommend scheduled SC insulin therapy consisting of basal or intermediate-acting insulin given once or twice daily in combination of rapid or short-acting insulin administered before meals in patients who are eating.”
  • 1 ☺☺☺☺

JCEM 2012;97:16-38
Glucose Control in Dexamethasone-Treated Patients with T2DM and Hematologic Malignancy

Retrospective review of 40 patients

mg/dL

Endocrine Practice 2013;19:231-235
Rabbit 2 Trial: Changes in Glucose Levels With Basal-Bolus vs. Sliding Scale Insulin


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

\[ aP<.05. \]
\[ bP<.05. \]
Case: Why SSI Doesn’t Work

This is a 55 year-old man with type 2 diabetes using metformin and glipizide with an A1C of 9.5%. He is admitted into the hospital with acute prostatitis and appears septic. He is too sick to eat. The in-patient physician begins “sliding scale” SC regular insulin q 4 hours
Initial glucose on the floor: 295 mg/dl
12 units “R” at 6 pm
Glucose at 10 pm: 180 mg/dl; 6 units R
Antibiotic with D5 infused at midnight
Glucose at 2 am: 180 mg/dl; 6 units R
Glucose at 6 am: 35 mg/dl, patient having seizure
Glucodynamic Principles: “R” and “insulin stacking”

Euglycemic Clamp Profile

Glucose Infusion Rate (mg/kg min)

Diabetes Care 22:1501, 1999
Glucodynamic Principles:
“R” and “insulin stacking”

Euglycemic Clamp Profile

Glucose Infusion Rate (mg/kg min)

Time (minutes)

0 120 240 360 480 600

0 100 200 300 400 500 600 700 800

Seizure at 6 am

Diabetes Care 22:1501, 1999
Rabbit Surgery Trial
Glucose levels during Basal Bolus and SSRI Therapy

Blood Glucose (mg/dL)

Randomization

Glucose levels during Basal Bolus and SSRI Therapy

* p<0.001
† p: 0.01
‡ p: 0.02
## Hospital Complications: Primary Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>ALL</th>
<th>SSI</th>
<th>Basal Bolus</th>
<th>P value</th>
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<tbody>
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<td>Wound infections</td>
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<td>11</td>
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<td>Acute renal failure</td>
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<td>11</td>
<td>4</td>
<td>0.106</td>
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<td>Bacteremia</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0.999</td>
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<tr>
<td><strong>Total # of complications</strong></td>
<td><strong>42</strong></td>
<td><strong>32</strong></td>
<td><strong>9</strong></td>
<td><strong>0.003</strong></td>
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<tr>
<td>Post-surg ICU admission</td>
<td>34</td>
<td>21</td>
<td>13</td>
<td>0.159</td>
</tr>
<tr>
<td>% post-surg ICU admission</td>
<td>16%</td>
<td>19.6%</td>
<td>12.5%</td>
<td></td>
</tr>
<tr>
<td>ICU LOS</td>
<td>2.51±1.90</td>
<td>3.19±2.14</td>
<td>1.23±0.60</td>
<td>0.003</td>
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</tbody>
</table>
Keys To Success

• Agreement between all clinicians and stake-holders to glycemic targets and general philosophies of insulin use

• Education with staff, communication between staff, examination for staff for continued improvement

• A “champion” for each specialty to address questions and concerns

• An appropriate culture to prioritize and standardize glycemic control
UWMC: Our Story

• 1992: initiation of IV insulin protocols throughout the hospital due to several “near-misses” with use of SC insulin
  • Consider
    • Before any controversy of TGC in the hospital
    • Before the introduction of insulin analogues
    • This more than anything else changed our *culture* of insulin Rx in the hospital
More History

• 2001-2002
  • Since over six IV protocols and NO SC protocols, decided to standardize all insulin orders
  • Van den Berghe SICU targets from 2001 seemed too ambitious for us, especially in non-ICU areas
  • Target: 100-180 mg/dL with implementation of IV 2002-2003, SC 2003-2004
Critical Care Non Critical Care

% Time Hyperglycemic

% Time BG<60 mg/dL. Normalized for Duration of Time on IV Insulin Drip

What About SC Insulin

• Much more difficult problem, especially outside of the ICU setting
  • Little data in terms of efficacy, safety, or outcome
  • Philosophies of insulin therapy disparate, even amongst “experts”
  • What allowed us to standardize our approach and thinking
Discontinue Insulin Infusion 1 hr after administering 1st dose of subQ basal insulin

Blood Glucose (BG) Monitoring:
- Before meals and bedtime OR every 6 hours if not eating meals
  - Pre-meal goal BG = 100-150 mg/dL OR ______ (range)
  - Bedtime goal BG = 100-180 mg/dL OR ______ (range)
- Optional BG Monitoring:
  - ______ Hrs after meals.
  - 2-3 am

Hypoglycemia Protocol (BG<70 mg/dL)
- A. If patient can take PO, give 4 oz fruit juice/non diet soda or 8 oz nonfat milk
- B. If patient is awake and alert but cannot take PO, give 12 mL of D50 as IV push OR glucagon 0.5mg SubQ/IM (if no IV access)
- C. If patient is NOT awake and alert, give 25 mL of D50 IV push or glucagon 1mg SubQ/IM
- D. Check finger stick glucose every 15 min and repeat above if blood glucose is less than 80 mg/dL

One time order for insulin on ____________(date and time):
- Give ______ units of:
  - Lispro (Humalog®)
  - Aspart (Novolog®)
  - U-100 Regular
- Give ______ units of basal:
  - NPH
  - Glargine (Lantus®)
  - Detemir (Levemir®)

Patient to self administer insulin?  No  Yes (pharmacy please send patient specific insulin vials)
## Scheduled Insulin Doses

<table>
<thead>
<tr>
<th></th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
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<tbody>
<tr>
<td><strong>Nutritional Insulin Orders</strong></td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
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<tr>
<td></td>
<td>□ Lispro (Humalog®)</td>
<td>□ Lispro (Humalog®)</td>
<td>□ Lispro (Humalog®)</td>
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<tr>
<td></td>
<td>□ Aspart (Novolog®)</td>
<td>□ Aspart (Novolog®)</td>
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</tr>
<tr>
<td></td>
<td>□ U-100 Regular</td>
<td>□ U-100 Regular</td>
<td>□ U-100 Regular</td>
<td>□ U-100 Regular</td>
</tr>
<tr>
<td><strong>CAUTION:</strong> U-500 insulin (5X conc) should only be used for insulin resistant patients (taking greater than 50 units of U-100 insulin per meal). U-500 insulin orders are written as a measure of units in a U-100 syringe rather than actual units of insulin potency.</td>
<td></td>
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<tr>
<td></td>
<td>□ U-500 Regular</td>
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<td></td>
<td>= _____ units in</td>
<td>= _____ units in</td>
<td>= _____ units in</td>
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<tr>
<td></td>
<td>U-100 syringe</td>
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<td>U-100 syringe</td>
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<tr>
<td><strong>Basal Insulin Orders</strong></td>
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<tr>
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<td>□ Glargine (Lantus®)</td>
<td>□ Glargine (Lantus®)</td>
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</tr>
<tr>
<td></td>
<td>□ Detemir (Levemir®)</td>
<td>□ Detemir (Levemir®)</td>
<td>□ Detemir (Levemir®)</td>
<td>□ Detemir (Levemir®)</td>
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<tr>
<td><strong>Premixed Insulin</strong></td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
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<tr>
<td></td>
<td>□ 70/30 (NPH/Reg)</td>
<td>□ 70/30 (NPH/Reg)</td>
<td>□ 70/30 (NPH/Reg)</td>
<td>□ 70/30 (NPH/Reg)</td>
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<tr>
<td><strong>Non-formulary Insulin ★</strong></td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
<td>Give _____ units of:</td>
</tr>
<tr>
<td></td>
<td>□ Glulisine (Apidra®)</td>
<td>□ Glulisine (Apidra®)</td>
<td>□ Glulisine (Apidra®)</td>
<td>□ Glulisine (Apidra®)</td>
</tr>
</tbody>
</table>

★ Orders for non-formulary insulin must be accompanied by a non-formulary request form. Please call pharmacy for assistance. For dosing questions for individual patients page the Diabetes Nurse Specialist.
Correction algorithms for Hyperglycemia: These algorithms are intended to supplement scheduled insulin. Please indicate when patient is to receive correction insulin by checking ALL appropriate boxes below:

- PREMEAL Correction (not to be given more frequently than every 4 hours)
- BEDTIME Correction  **MANDATORY BG CHECK AT 2-3 AM IF BEDTIME CORRECTION IS GIVEN**
- EVERY 6 hours for NPO patients only using the PREMEAL algorithm
- 2-3 AM Correction (Use bedtime algorithm) **MANDATORY BG CHECK AT 6 AM IF CORRECTION IS GIVEN**

Indicate the type of insulin to be used for correction by checking a box below:

- Lispro (Humalog®) – Available as floor stock on all units
- Aspart (Novolog®) – For patients receiving Aspart as prandial insulin
- Glulisine (Apidra®) – NONFORMULARY (Patient must have own supply)

(Must specify LOW, MEDIUM, HIGH or INDIVIDUALIZED below)
Correction Dose Insulin for Premeal Hyperglycemia, Low and Medium Dose

### Low-Dose Algorithm
(For pts requiring < 40 units of insulin/day)

<table>
<thead>
<tr>
<th>Premeal BG</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>1 unit</td>
</tr>
<tr>
<td>200-249</td>
<td>2 units</td>
</tr>
<tr>
<td>250-299</td>
<td>3 units</td>
</tr>
<tr>
<td>300-349</td>
<td>4 units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>5 units</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bedtime BG</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>None</td>
</tr>
<tr>
<td>200-249</td>
<td>1 unit</td>
</tr>
<tr>
<td>250-299</td>
<td>2 units</td>
</tr>
<tr>
<td>300-349</td>
<td>3 units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>4 units</td>
</tr>
</tbody>
</table>

### Medium-Dose Algorithm
(For pts requiring 40–80 units of insulin/day)

<table>
<thead>
<tr>
<th>Premeal BG</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>1 unit</td>
</tr>
<tr>
<td>200-249</td>
<td>3 units</td>
</tr>
<tr>
<td>250-299</td>
<td>5 units</td>
</tr>
<tr>
<td>300-349</td>
<td>7 units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>8 units</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bedtime BG</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>None</td>
</tr>
<tr>
<td>200-249</td>
<td>2 units</td>
</tr>
<tr>
<td>250-299</td>
<td>3 units</td>
</tr>
<tr>
<td>300-349</td>
<td>5 units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>7 units</td>
</tr>
</tbody>
</table>
Correction Dose Insulin for Premereal Hyperglycemia, High and Individualized Dose

### High-Dose Algorithms
(For pts requiring > 80 units of insulin/day)

<table>
<thead>
<tr>
<th>Premeal</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>2 units</td>
</tr>
<tr>
<td>200-249</td>
<td>4 units</td>
</tr>
<tr>
<td>250-299</td>
<td>7 units</td>
</tr>
<tr>
<td>300-349</td>
<td>10 units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>12 units</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bedtime</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>None</td>
</tr>
<tr>
<td>200-249</td>
<td>2 units</td>
</tr>
<tr>
<td>250-299</td>
<td>5 units</td>
</tr>
<tr>
<td>300-349</td>
<td>7 units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>10 units</td>
</tr>
</tbody>
</table>

### Individualized Algorithms

<table>
<thead>
<tr>
<th>Premeal</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>_____ units</td>
</tr>
<tr>
<td>200-249</td>
<td>_____ units</td>
</tr>
<tr>
<td>250-299</td>
<td>_____ units</td>
</tr>
<tr>
<td>300-349</td>
<td>_____ units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>_____ units</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bedtime</th>
<th>Additional Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>_____ units</td>
</tr>
<tr>
<td>200-249</td>
<td>_____ units</td>
</tr>
<tr>
<td>250-299</td>
<td>_____ units</td>
</tr>
<tr>
<td>300-349</td>
<td>_____ units</td>
</tr>
<tr>
<td>&gt;349</td>
<td>_____ units</td>
</tr>
</tbody>
</table>
Big Picture: What Does The Research Tell Us About Inpatient Glucose Control?

- Despite the concerns about hypoglycemia, the real problem in the hospital remains untreated hyperglycemia both in the ICU and on the floors.
- Despite controversy about actual targets, the real enemy is lack of attention to glycemia in general and intimidation of insulin use due to lack of training and new concerns about hypoglycemia.
Summary: Is There A Controversy?

• Current targets should be attainable and are safe for most hospitals (and would be an improvement to the hyperglycemia-management seen in many if not most hospitals)

• The goal of “TGC” is not a realistic target for most hospitals due to the same reasons it was not possible in NICE-SUGAR and other RCTs, perhaps the most important reason being lack of appropriate technology (CGM)
My Thought

- The introduction of CGM (at least in the ICU) will make TGC and near-normoglycemia possible and only then can appropriate clinical trials be performed.