Simple steps to Meet Inpatient Glycemic Control Goals

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RCT Glycemic Control Targets in Critically Ill Patients

Intensive Target Range: Mean achieved

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“Conventional” Target Range: Mean = yellow bar

Leuven SICU

VISEP

Glucontrol

NICE SUGAR

BG <40 70 100 130 140 160 180 200 250 299 400
NICE-SUGAR Study: Design

6104 ICU patients

“Conventional”
IV insulin if BG >180 mg/dL
Target: 140-180 mg/dL

69% insulin
BG = 144 mg/dL

“Intensive”
IV insulin if BG >108 mg/dL
Target: 81-108 mg/dL

97% insulin
BG = 115 mg/dL

NICE-SUGAR

• Intensive control vs conventional control
  • Mortality 27.5% vs 24.9%; $P = 0.02$
  • $ARR = 27.5\% - 24.9\% = 2.6\% \Rightarrow NNH = 38$
  • Severe hypoglycemia (BG ≤40 mg/dl)
    6.8% vs 0.5%; $P<0.001$

• No significant difference between the two treatment groups in the median number of days in the ICU or hospital

Recent Guidelines

- American Association of Clinical Endocrinologists And American Diabetes Association CONSENSUS STATEMENT ON INPATIENT GLYCEMIC CONTROL ENDOCRINE PRACTICE May/June 2009


- Management of Hyperglycemia in Hospitalized Patients in Non-Critical Care Setting: An Endocrine Society Clinical Practice Guideline J Clin Endocrinol Metab 2012
Current Recommended Targets for ICU = 140-180 mg/dL

- NICE Sugar
- 2009 AACE/ADA goals
- 2011 ACP guideline

<40  70  100  130  140  160  180  200  250  299  400

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“Use of Intensive Insulin Therapy for the Management of Glycemic Control in Hospitalized Patients: A Clinical Practice Guideline From the ACP”

- **Recommendation 1:** ACP recommends *not* using intensive *insulin therapy* to strictly control blood glucose in 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 140 to 200 mg/dL if insulin therapy is used in SICU/MICU patients (Grade: weak recommendation, moderate-quality evidence).

Target Glucose Levels in ICU Patients

AACE/ADA

<table>
<thead>
<tr>
<th></th>
<th>Not recommended</th>
<th>Acceptable 110-140</th>
<th>Recommended 140-180</th>
<th>Not recommended &gt;180</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;110</td>
<td>Red</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>110-140</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>140-180</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>&gt;180</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

ACP recommends 140-200

ACP

For the majority of noncritically ill patients treated with insulin, the premeal BG target should generally be <140 mg/dl in conjunction with random BG <180 mg/dl.

—DIABETES CARE, VOLUME 32, NUMBER 6, JUNE 2009
—J Clin Endocrinol Metab 97: 16–38, 2012
Antihyperglycemic Therapy

Insulin
Recommended

Oral Agents
Not Generally Recommended

IV Insulin
Critically ill ICU patients

SC Insulin
Non-critically ill patients

Uncontrolled Hyperglycemia is common in patients with diabetes

Does this look familiar?
• Non-critically ill patients: “Scheduled subcutaneous administration of insulin, with basal, nutritional, and correction components, is the preferred method for achieving and maintaining glucose control.”

—DIABETES CARE, VOLUME 32, NUMBER 6, JUNE 2009
Physiologic Insulin Replacement: Basal – Bolus Regimens

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin (µU/mL)</td>
<td>50% Basal Insulin</td>
<td>50% Bolus Insulin</td>
</tr>
</tbody>
</table>

- Aspart
- Lispro
- Glulisine
- Regular

- Total Daily Dose (TDD)
- Glargine
- Detemir
- NPH
RABBIT-2 Trial: Basal / Bolus arm

- **Patients:** Type 2 DM, non-surgical X at least 3 months on diet or orals
- **Regimen:** D/C oral antidiabetic drugs on admission
- Starting total daily dose (TDD):
  - 0.4 U/kg/d x BG between 140-200 mg/dL
  - 0.5 U/kg/d x BG between 201-400 mg/dL
- TDD adjusted daily +/- 20% for BG >140 or < 70
- 50% of TDD as insulin glargine and half as rapid-acting insulin (glulisine)

Umpierrez et al, Diabetes Care 30:2181–2186, 2007
Mean Blood Glucose Levels During Insulin Therapy

Umpierrez, Diabetes Care 30: 2007
Blood Glucose Levels in Patients Who Failed SSRI: Transition to Basal Bolus Insulin

Failure was defined as 3 consecutive BG values > 240 mg/dL during SSRI

Umpierrez, Diabetes Care 30: 2007
Rabbit 2 Surgery Trial

211 Patients with type 2 DM
Who underwent general surgery

OPEN- LABELED RANDOMIZATION

Glargine + Glulisine
N= 104

: 0.5 U/kg
Half as glargine once daily
Half as glulisine
before meals

Sliding scale insulin
N= 107

4 times/day for
BG >140 mg/dl

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011
Postoperative Complications

* Composite of hospital complications: wound infection, pneumonia, respiratory failure, acute renal failure, and bacteremia.

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011
Effect of Structured Insulin Orders and an Insulin Management Algorithm – UCSD

5,530 patients with DM or Hyperglycemia and > 7 POC Glucose readings TP3:TP1

- RR Uncontrolled Patient-Day – 0.77 (0.74 - 0.80)
- RR Uncontrolled Patient-Stay (70% controlled vs. 60%) – 0.73 (0.66 - 0.81)
- RR Hypoglycemic Patient-Day (prevents 208 / year) – 0.68 (0.59 - 0.80)
- RR Hypoglycemic Patient-Stay – 0.77 (0.64 - 0.92)

UCSD Experience % of 9,314 Patient Stays with Uncontrolled Hyperglycemia
3 Steps to using basal/bolus insulin in the hospital

1. Determine total daily insulin dose
2. Divide up to 50% basal insulin, 50% bolus
3. Adjust daily
Step 1: Calculate Starting total daily dose (TDD):

1. IV requirements
2. Home dose— (consider reduction by 25%)
3. Weight based 0.2-0.5 units/kg/day
   1. Most recent guides say 0.2-0.5
   2. Rabbit trials 0.3-0.5
      - 0.3 ESRD or elderly (>70 y.o.)
      - 0.4 units/kg/day if admit BG 140-200
      - 0.5 units/kg/day if admit BG >200
3. BGSMC 0.3-0.6 based on insulin sensitivity predictors
Step 2: Divide into Scheduled Basal vs. Nutritional Insulin

• 40-50% should generally be basal (glargine, detimir, or NPH)
• Remaining 50-60% divided evenly and given to cover nutritional intake
  – Rapid acting (lispro, aspart, glulisine) easier to match with meals in hospital
  – Regular insulin also an option
Step 3: Adjust Doses Daily

- Blood glucose targets can only be achieved via continuous management of the insulin program.
- *There is no “autopilot” insulin regimen for a hospitalized patient!*
<table>
<thead>
<tr>
<th>Fasting BG</th>
<th>Adjustment</th>
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</thead>
<tbody>
<tr>
<td>100-140 mg/dL</td>
<td>No change</td>
</tr>
<tr>
<td>140-180 mg/dl</td>
<td>Increase TDD by 10% daily</td>
</tr>
<tr>
<td>&gt;180 mg/dl</td>
<td>Increase TDD by 20% daily</td>
</tr>
<tr>
<td>70-99 mg/dl</td>
<td>Decrease TDD by 10%</td>
</tr>
<tr>
<td>&lt;70 mg/dl</td>
<td>Decrease by 20%</td>
</tr>
</tbody>
</table>

* Note: only increase the doses if NONE were <100mg/dl.
My Suggestions for Daily Adjustment

1. Any less than 100 mg/dL or > 180?

2. Add up previous day’s TDD
   - Include amount given as supplemental insulin
   - Adjust up or down by depending on degree of hypo- and hyperglycemia
   - Adjust for other factors (renal function, steroid dose, nutritional intake, severity of illness)

3. Divide new TDD into basal and nutritional components
   - Split 50/50 OR
   - Adjust basal and nutritional separately, depending on AM fasting vs. late day sugars
   - Watch out for too much basal
Case Take home points

• Do not use split mixed insulins for inpatients because it lacks flexibility!
• Your correction insulin should be the same as the nutritional
• If you are confused about insulin names, imagine the nursing staff
The HOME stretch!

But my patient won’t be able to afford/manage/comply/etc with basal/bolus as an outpatient.
Failure to Identify Diabetes Is a Predictor of Rehospitalization

Robbins JM, Webb DA. Med Care. 2006;44:292-296

Readmission Rates

- Diabetes First Diagnosed During Hospitalization: 9.4%
- Diabetes Diagnosis Missed During Hospitalization: 31.0%
Achieving safe and effective transitions to home

• The admission HbA1c to indicate the patient’s glycemic status *before they became ill*
  – ≤ 5.7 = normal glucose metabolism
  – 5.7 - 6.4 = ‘pre-diabetes’ (high risk for DM)
  – ≥ 6.5 = diabetes
  – ≥ 8.0 = poorly controlled diabetes
Factors Used for Selecting Discharge Therapy for Patients with Known Diabetes

- Control at home and admission HbA$_{1C}$
- Home regimen prior to admission
- Admission reason: Hypoglycemia, Acute MI, Related to hyperglycemia (DKA, HHS, etc.)
- Physical limitations
- New co-morbidities that may limit prior oral therapy
- Hypoglycemia risk factors
- Treatment goals (i.e. hospice)
- Frequency of self monitoring
- Financial $$$$$
Discharge Treatment Algorithm: AACE

- **A1C < 7%**
  - Re-start outpatient treatment regimen (OAD and/or insulin)

- **A1C 7%-9%**
  - Re-start outpatient oral agents and D/C on glargine once daily at 50-80% of hospital dose

- **A1C >9%**
  - D/C on basal bolus at same hospital dose.
  - Alternative: re-start oral agents and D/C on glargine once daily at 50-80% of hospital dose

http://resources.aace.com/pages.asp.29.html
Selecting Discharge Therapy

Take Home Messages

• Good to do something but don’t get too aggressive because the time after discharge is high risk for hypoglycemia

• Once A1C is >8.5% additional oral agents are unlikely to achieve goals

• Insulin at bedtime with or without oral agents is a good initial strategy

• Tailor glycemic target to individual
Additional Resources for Physician Education

- American Association of Clinical Endocrinology Inpatient glycemic control resource center: https://www.aace.com/education/igrc
- Johns Hopkins Consultative Medicine Essentials for Hospitalists: http://www.jhcape.com or shmconsults.com
- Quantia MD What is involved in the practical management of blood sugars postoperatively? 
- Quantia MD What is involved in the practical management of insulin preoperatively? 
  - http://quantiamd.com/player/rumyejs?cid=53
Questions

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References

- Intensive versus Conventional Glucose Control in Critically Ill Patients, N Engl J med 360;13 March 26, 2009
- Queale WS et al, Ann Int Med, 1997; 157
- Becker T et al., Clinical outcomes associated with the use of subcutaneous insulin-by-glucose sliding scales to manage hyperglycemia in hospitalized patients with pneumonia Diabetes Research and Clinical Practice 78 (2007) 392–397
- Umpierrez GE, et al, Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes (RABBIT 2 Trial), Diabetes Care 30: 2007