HOSPITAL DIABETES: PAST AND PRESENT

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DISCLOSURE

- Regional Consultant Panel for Lixisenatide & iGlarLixi (Sanofi).
OBJECTIVES

- Discuss the ADA/AACE Recommendations for In-Patient Glycemic Control.

- Describe insulin concepts (basal, prandial and correction).

- Understand the importance of insulin timing.

- Analyze the evidence and role of IV Insulin Infusion protocols in the hospital.

- Discuss hypoglycemia in the hospital setting.
Hospital Barriers to Glucose Control in Hospitalized Patients

- **Admission orders** – oral agents and/or insulin are either continued unchanged, or more likely discontinued upon admission.

- **Glucose targets too high** – BG is commonly allowed to reach > 200 mg/dL (300 often tolerated).

- **Lack of therapeutic adjustment** – Results of bedside monitoring are not used to guide pharmacological regimen.

- **Overutilization of insulin sliding scales**

BARRIERS AND CHALLENGES TO ACHIEVING INPATIENT GLYCEMIC CONTROL

Barriers to adequate control of inpatient hyperglycemia include:

- Fear of inducing hypoglycemia.
- Uneven knowledge and training of staff.
- Competing institutional and patient priorities.

Barriers and Challenges to Achieving Inpatient Glycemic Control

Management challenges of the inpatient environment that can undermine efforts to achieve glycemic control:

- Patients often move across multiple care teams.
- Insulin requirements may change dramatically during stay.
- Many hospitals lack protocols.

ADA/AACE RECOMMENDATIONS FOR IN-PATIENT GLYCEMIC CONTROL

- Critically ill patients:
  - Once insulin therapy is started, a glucose range of 140-180 mg/dL is recommended for the majority of critically ill patients.

- Non-critically ill patients:
  - For the majority of noncritically ill patients, treatment with insulin, the premeal BG target should be < 140 mg/dL in conjunction with random BG values < 180 mg/dL provided these targets can be safely achieved.

Diabetes Care, 38, January 2015: S80-S85.
Non-critically ill Patients

To avoid hypoglycemia:

- Consideration should be given to reassessing the insulin regimen if BG levels fall below 100 mg/dL.

- Modifying of the regimen is required when blood glucose values are <70 mg/dL, unless the event is easily explained by other factors (such as a missed meal).

Diabetes Care, 38, January 2015: S80-S85.
# Criteria for the Diagnosis of Diabetes

**Table 2—Criteria for the diagnosis of diabetes**

A1C ≥6.5%. The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*

<table>
<thead>
<tr>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPG ≥126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h.*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-h plasma glucose ≥200 mg/dL (11.1 mmol/L) during an OGTT. The test should be performed as described by the WHO, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥200 mg/dL (11.1 mmol/L)</td>
</tr>
</tbody>
</table>

*In the absence of unequivocal hyperglycemia, result should be confirmed by repeat testing.

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Diabetes Care 2012 (Supp 1); 35: S11-S63.
1997 ADA Diagnostic Guidelines

- **FPG**
  - \( >100 = IFG \)
  - \( >126 = Diabetes \)

- **75g OGTT**
  - \( >140 = IGT \)
  - \( >200 = Diabetes \)

From *Diabetes Care* Clinical Practice Recommendations 2002.
INSULIN REQUIREMENTS IN HEALTH AND ILLNESS

Relative Proportion of Insulin Requirement (%)*

Illness-Related
- Correction
- Nutritional
- Prandial
- Basal

*Estimations for illustrative purposes: requirements may vary widely.

INSULIN CONCEPTS

- Basal
- Prandial
- (Correction insulin may be added to the prandial dose.)
THE BASAL/BOLUS INSULIN CONCEPT

- **Basal Insulin**
  - Suppresses glucose production between meals and overnight.
  - Nearly constant levels.
  - 50% of daily needs.

- **Bolus Insulin (Mealtime or Prandial)**
  - Limits hyperglycemia after meals.
  - Immediate rise and sharp peak at 1 hour.
  - 10% to 20% of total daily insulin requirement at each meal.

- Ideally, for insulin replacement therapy, each component should come from a different insulin with a specific profile.

High-Alert Medication Errors by Harm Category 2006–2008

Of those ADEs where harm occurred, the majority resulted from insulin, heparin, and warfarin, following the frequency of use and error curves. Digoxin and promethazine were also associated with harm.

* Harm as indicated by NCC-MERP categories E-I
High-Alert Medication Errors by Type of Error Category 2006–2008
Figure 3 shows the distribution of the processes where the medication errors were initiated, with the highest reported instances taking place during the administering and dispensing processes (29% each), followed by the transcribing/documenting process at 25%.

# Insulins Available in the United States

<table>
<thead>
<tr>
<th>Generic Name (U-100, except where noted)</th>
<th>Brand Name</th>
<th>Manufacturer</th>
<th>Form</th>
<th>Delivery</th>
<th>Cloudy or Clear</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rapid Acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin aspart</td>
<td>NovoLog</td>
<td>Novo Nordisk</td>
<td>analog</td>
<td>syringe; prefilled, 300-unit disposable pen; reusable pen with 300-unit cartridges; pump</td>
<td>clear</td>
<td>10 to 20 min.</td>
<td>30 to 90 min.</td>
<td>3 to 5 hours</td>
</tr>
<tr>
<td>Insulin human</td>
<td>Afreza</td>
<td>Sanofi</td>
<td>human</td>
<td>inhaler with 4- and 8-unit cartridges</td>
<td>N/A (inhaled powder)</td>
<td>10 to 20 min.</td>
<td>12 to 15 min.</td>
<td>3 hours</td>
</tr>
<tr>
<td>Insulin glulisone</td>
<td>Apidra</td>
<td>Sanofi</td>
<td>analog</td>
<td>syringe; prefilled, 300-unit disposable pen; pump</td>
<td>clear</td>
<td>10 to 20 min.</td>
<td>30 to 90 min.</td>
<td>3 to 5 hours</td>
</tr>
<tr>
<td>Insulin lispro</td>
<td>Humalog*</td>
<td>Eli Lilly</td>
<td>analog</td>
<td>syringe, prefilled disposable pen, reusable pen with cartridges; pump</td>
<td>clear</td>
<td>10 to 20 min.</td>
<td>30 to 90 min.</td>
<td>3 to 5 hours</td>
</tr>
<tr>
<td><strong>Regular</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>Humulin R*</td>
<td>Eli Lilly</td>
<td>human</td>
<td>syringe</td>
<td>clear</td>
<td>30 to 60 min.</td>
<td>2 to 4 hours</td>
<td>5 to 8 hours</td>
</tr>
<tr>
<td>Regular</td>
<td>Novolin R</td>
<td>Eli Lilly</td>
<td>human</td>
<td>syringe</td>
<td>clear</td>
<td>30 to 60 min.</td>
<td>2 to 4 hours</td>
<td>5 to 8 hours</td>
</tr>
<tr>
<td><strong>Intermediate Acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH</td>
<td>Humulin N</td>
<td>Eli Lilly</td>
<td>human</td>
<td>syringe; prefilled, 300-unit disposable pen</td>
<td>cloudy</td>
<td>1 to 3 hours</td>
<td>8 hours</td>
<td>12 to 16 hours</td>
</tr>
<tr>
<td>NPH</td>
<td>Novolin N, ReliOn (Walmart)</td>
<td>Novo Nordisk</td>
<td>human</td>
<td>syringe</td>
<td>cloudy</td>
<td>1 to 3 hours</td>
<td>8 hours</td>
<td>12 to 16 hours</td>
</tr>
<tr>
<td><strong>Long Acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin detemir</td>
<td>Levemir</td>
<td>Novo Nordisk</td>
<td>analog</td>
<td>syringe; prefilled, 300-unit disposable pen</td>
<td>clear</td>
<td>1 hour</td>
<td>No peak</td>
<td>20 to 26 hours</td>
</tr>
<tr>
<td>Insulin glargine</td>
<td>Lantus</td>
<td>Sanofi</td>
<td>analog</td>
<td>syringe; prefilled, 300-unit disposable pen</td>
<td>clear</td>
<td>1 hour</td>
<td>No peak</td>
<td>24 hours</td>
</tr>
<tr>
<td><strong>Ultra Long Acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin glargine U-300</td>
<td>Toujeo</td>
<td>Sanofi</td>
<td>analog</td>
<td>prefilled, 450-unit disposable pen</td>
<td>clear</td>
<td>6 hours</td>
<td>No peak</td>
<td>36 hours</td>
</tr>
<tr>
<td><strong>Mixtures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% lispro protamine/50% insulin lispro</td>
<td>Humalog Mx 50/50</td>
<td>Eli Lilly</td>
<td>analog</td>
<td>syringe; prefilled, 300-unit disposable pen</td>
<td>cloudy</td>
<td>10 to 15 min.</td>
<td>Varies</td>
<td>10 to 16 hours</td>
</tr>
<tr>
<td>75% lispro protamine/25% insulin lispro</td>
<td>Humalog Mx 75/25</td>
<td>Eli Lilly</td>
<td>analog</td>
<td>syringe; prefilled, 300-unit disposable pen</td>
<td>cloudy</td>
<td>10 to 15 min.</td>
<td>Varies</td>
<td>10 to 16 hours</td>
</tr>
<tr>
<td>70% aspart protamine/30% insulin aspart</td>
<td>NovoLog Mx 70/30</td>
<td>Novo Nordisk</td>
<td>analog</td>
<td>syringe; prefilled, 300-unit disposable pen</td>
<td>cloudy</td>
<td>5 to 15 min.</td>
<td>Varies</td>
<td>10 to 16 hours</td>
</tr>
<tr>
<td>70% NPH/30% Regular</td>
<td>Humulin 70/30</td>
<td>Eli Lilly</td>
<td>human</td>
<td>syringe; prefilled, 300-unit disposable pen</td>
<td>cloudy</td>
<td>30 to 60 min.</td>
<td>Varies</td>
<td>10 to 16 hours</td>
</tr>
<tr>
<td>70% NPH/30% Regular</td>
<td>Novolin 70/30, ReliOn (Walmart)</td>
<td>Novo Nordisk</td>
<td>human</td>
<td>syringe</td>
<td>cloudy</td>
<td>30 to 60 min.</td>
<td>Varies</td>
<td>10 to 16 hours</td>
</tr>
<tr>
<td><strong>Less Commonly Used Insulins</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>regular U-500</td>
<td>Humulin R U-500*</td>
<td>Eli Lilly</td>
<td>human</td>
<td>syringe</td>
<td>clear</td>
<td>30 min.</td>
<td>8 hours</td>
<td>Up to 24 hours</td>
</tr>
<tr>
<td>insulin lispro U-200</td>
<td>Humalog U-200**</td>
<td>Eli Lilly</td>
<td>analog</td>
<td>prefilled, 600-unit disposable pen</td>
<td>clear</td>
<td>15</td>
<td>30 to 90 min.</td>
<td>3 to 5 hours</td>
</tr>
</tbody>
</table>

**Key**

* Note difference between Humalog and Humalog U-200. † Note difference between Humulin R and Humulin R U-500. ‡ Note difference between Novolin 70/30 (70% NPH/30% Regular) and NovoLog Mx 70/30 (70% aspart protamine/30% aspart). A U-100, U-200, U-300, and U-500 are different concentrations of insulin. Higher concentrations are typically used in very insulin-resistant people.
Insulins on Formulary at the Medical University of South Carolina (MUSC)

- Regular insulin for IV infusions and SQ for hyperkalemia.
- Aspart insulin for correction/prandial dose.
- NPH insulin for basal coverage.
- Glargine insulin for basal coverage.
- U-500 insulin for severe insulin resistance
  - Restricted use by Diabetes Management Service:
    - Currently, TB syringes and U-100 syringes are used.
    - Fall 2016 – first U-500 insulin syringe (green).
    - U-500 Pen available.
What is Humulin R U-500?
U-500 is 5 times more concentrated than standard U-100 insulin and is specifically for people like you—people whose A1C levels are above their targets even though they’ve been taking more than 200 units of insulin a day.

There are 2 different ways to take Humulin R U-500:

Current practice is to use U-100 insulin syringes or TB Syringes. Once the new U-500 insulin syringe is available later this year, FDA Recommends U-100 insulin and TB syringes should no longer be used.
# Correction

## Sliding Scale Insulin

<table>
<thead>
<tr>
<th>BG (mg/dL)</th>
<th>Highly Insulin Sensitive</th>
<th>Normal Insulin Sensitivity (for most patients)</th>
<th>Highly Insulin Resistant</th>
<th>AC</th>
<th>HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;150</td>
<td>0U</td>
<td>0U</td>
<td>0U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150–199</td>
<td>1U</td>
<td>2U</td>
<td>3U</td>
<td>0 unit</td>
<td></td>
</tr>
<tr>
<td>200–249</td>
<td>2U</td>
<td>4U</td>
<td>6U</td>
<td>1 unit</td>
<td></td>
</tr>
<tr>
<td>250–299</td>
<td>3U</td>
<td>6U</td>
<td>9U</td>
<td>2 unit</td>
<td></td>
</tr>
<tr>
<td>300–349</td>
<td>4U</td>
<td>8U</td>
<td>12U</td>
<td>3 unit</td>
<td></td>
</tr>
<tr>
<td>≥350</td>
<td>5U</td>
<td>10U</td>
<td>15U</td>
<td>4 unit</td>
<td></td>
</tr>
</tbody>
</table>

Varies; 1-5 units safe for all
**Insulin Stacking**

Historically, sliding scale Regular insulin was the issue now rapid acting insulins are a concern:

- 40\% of aspart insulin is still around at 3 hours.
- Need a minimum of 4 hours between SQ doses.
- Correction insulin (sliding scale, supplemental, bolus).

**Problems**

- Dosed too frequently.
- Ordered doses too high.
- Often no basal insulin ordered.
The use of this graph helps patients avoid “insulin stacking.” For example, three hours after the administration of 10 units of insulin aspart, one can estimate that there is still 40 percent times 10 units, or 4 units, of insulin remaining.

**Adult Insulin Timing**

**Basal Insulin**
- Hourly insulin is needed to maintain blood glucose levels in between meals and overnight:
  - SC: glargine (Lantus) or NPH
  - SC Insulin pump: aspart (Novolog), lispro (Humalog) or glulisine (Apidra)
  - IV drip/TPN: Regular insulin
- BG ↑ 45 – 50mg/dL **hourly** when basal insulin is held in patients with type 1 diabetes

**NEVER HOLD BASAL INSULIN**

NPO: GIVE basal insulin

**Nutritional/Prandial/CHO Counting Insulin**
- Insulin used to cover a meal/snack: aspart (Novolog)
- Give before, during, or up to 30 minutes after eating a meal
- If patient does not eat 50% CHO on tray, prandial may be held or reduced per MD orders
- If pt on IVIIC & eating, prandial insulin must be given
- If AC POC BG >70mg/dL – GIVE prandial insulin

**Timing corresponds with ordered POC BGs (AC & HS, 3am, Q4, Q6). Must be given within 30 minutes of POC BG.**

NPO: HOLD prandial insulin

**Correction Bolus (Sliding Scale)**
- Additional units of insulin are required to attain target glucose:
  - aspart (Novolog)
  - May be given every 4-6 hours, but no sooner than every 4 hours

**Timing corresponds with ordered POC BGs (AC & HS, 3am, Q4, Q6). Must be given within 30 minutes of POC BG.**

NPO: GIVE correction insulin

*If you have a question or concern, contact the ordering provider!*

Revised 06/05/15
People do not always take insulin as prescribed.

What questions should you be asking?

- How many times per week do you miss an insulin dose?
- Do you take your insulin at prescribed times?
- Do you ever go low?
  - If so, what time of day?
  - Symptoms?
Guidelines: Weight Based Insulin Dosing

- **Basal insulin** (Glargine at bedtime or Q12 hr NPH):
  - 0.4 - 0.5 units/kg normally.
  - 0.3 units/kg concern over risk of hypoglycemia.
  - 0.7 units/kg for obesity, infections, post CABG, open wounds, metabolic.

- **Meal insulin** (Lispro, Aspart, Glulisine):
  - 0.1 units/kg.

- **± Supplement** (Correction, Sliding Scale):
  - 0.05 units/kg > 200 mg/dL; 0.075 units/kg > 300 mg/dL.

INDICATIONS FOR INTRAVENOUS INSULIN INFUSION

- Critical care illness (DKA, HHS, sepsis, etc).
- Myocardial infarction or cardiogenic shock.
- Post-operative period following heart surgery.
- Perioperative period.
- Labor & delivery.
- Prolonged NPO status.
- Organ transplantation.
- High-dose glucocorticoid Rx.
- Dose-finding strategy prior to conversion to SQ insulin.

ADA Clinical Practice Recommendations, Diabetes Care, 38, 2015: S80-S85.
**IMPROVED PATIENT OUTCOMES AND SURVIVAL FROM TIGHT CONTROL WITH INTRAVENOUS INSULIN (IVI)**


PORTLAND DIABETIC PROJECT (n=5510)

- Goal 150-200mg/dL (1992) with a gradual decrease to 70-110mg/dL at the end of the study.

- IVI protocol until morning day 3 postop.

- 75% reduction in cardiac related mortality for patients with diabetes undergoing CABG.

- 77% reduction in deep sternal wound infection (p<0.0001).

INSULIN INFUSION REDUCES WOUND INFECTIONS IN DIABETIC PATIENTS AFTER CARDIAC SURGERY:

THE PORTLAND PROTOCOL

Note: significant downward trend DSWI since start of CII

Mortality Among Post-CT Surgery Patients by Average Post-op Blood Glucose

N: 3,554

Parallel-group, randomized, controlled trial involving 42 hospitals in Australia, New Zealand, and Canada.

6104 adult medical and surgical patients admitted to the ICU and expected to require at least three days of ICU care were randomized to intensive or conventional insulin therapy.

- Intensive— IV insulin started if BS > 108
  - Goal 81-108
- Conventional— IV insulin started only if BS > 180
  - Goal 144-180

20% of patients had diabetes.

Primary endpoint: all-cause 90-day mortality.

INTENSIVE INSULIN THERAPY: NICE-SUGAR (2009)

- Intensive group
  - Actual glucose: 115 +/- 18 mg/dL
  - Patients with BS < 40: 6.8%
- Conventional group
  - Actual glucose: 144 +/- 23 mg/dL
  - Patients with BS < 40: 0.5%

INTENSIVE INSULIN THERAPY: NICE-SUGAR (2009)

Mortality:
Intensive: n=829 (27.5%)
Conventional: n=751 (24.9%)
P=0.03

Conclusions:

“Intensive glucose control, as compared with conventional glucose control, increased the absolute risk of death (in critically ill patients) at 90 days by 2.6 percentage points; this represents a number needed to harm of 38.”
Outcomes of a Cardiothoracic Intensive Care Web-Based Online Intravenous Insulin Infusion Calculator Study at a Medical University Hospital

KATHIE L. HERMAYER, M.D.,¹ DIANE E. NEAL, Ph.D.,² TIMOTHY V. HUSHION, B.A.,³ MICHAEL G. IRVING, M.S.,⁴ PAMELA C. ARNOLD, M.S.N.,³ LISA KOZLOWSKI, M.S.,³ MARTHA R. STROUD, M.S.,⁵ FRANK B. KERR, B.S.N.,⁵ and JOHN M. KRATZ, M.D.⁵
“Multiplier” IVI Protocol

- IVI rate is changed based on a formula that uses:
  
  - A “multiplier”: a surrogate for an insulin sensitivity factor.
  
  - And the difference between a measured blood glucose (BG) and a target blood glucose (TBG).

- Rate of insulin infusion/hour =
  
  \((\text{current BG} - 60 \text{ mg/dL}) \times 0.03\) (multiplier).
**ADULT IV Insulin Infusion Calculator**

Refer to the Physician Orders on the patient chart.

<table>
<thead>
<tr>
<th>New PATCOM</th>
<th>Choose a target blood glucose range:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GI Surgery / Islet Cell Transplant / MSICU / CT Surgery / CTICU: 110-140 mg/dL</td>
</tr>
<tr>
<td></td>
<td>MICU / CCU / NSICU / Adult Med/Surg.: 140-180 mg/dL</td>
</tr>
<tr>
<td></td>
<td>STICU: 80-110 mg/dL</td>
</tr>
<tr>
<td></td>
<td>DKA / HHNK: 150-200 mg/dL</td>
</tr>
<tr>
<td></td>
<td>L&amp;D: 70-110 mg/dL</td>
</tr>
<tr>
<td></td>
<td>Operative Patients: 110-140 mg/dL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Select PATCOM</th>
<th>Time Of Last Calculation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>---Select a Patient---</td>
<td>Previous Nurse:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Claim or Scan PATCOM</th>
<th>Go!</th>
</tr>
</thead>
</table>

Is this the Initiation of the IV insulin infusion?

Yes
No

What is the recorded Current Multiplier for the Previous time period OR the Starting Multiplier?

What is the present FSBG?

What is the recorded FSBG for the Previous time period?

The NEW Current Multiplier for this time period is:

The NEW Rate for the IV Insulin Infusion is:

*NEW Multiplier and the NEW Rate are to be recorded in the same box (under the present time period) on the DIABETES Monitoring and Insulin MAR Flow Sheet.

To clear all entered data, push this **RESET** button

*N Page Amy Hutto, RN at #11702 For Questions and Help

**Nursing Pearls**
# Comparison of BG Outcomes, 3 Cohorts Pre and Post-protocol IVIIC During the first 48 Hours Post-Operatively

<table>
<thead>
<tr>
<th>Group</th>
<th>Type 2 Diabetes, Pre-protocol, on Infusion</th>
<th>Type 2 Diabetes, Post-protocol</th>
<th>Without Type 2 Diabetes, Post-protocol</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (patients)</td>
<td>31</td>
<td>22</td>
<td>44</td>
<td>—</td>
</tr>
<tr>
<td>N (Mean) BG Drawn</td>
<td>964 (31.1)</td>
<td>847 (38.5)</td>
<td>1,286 (29.3)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean BG (48 hours)</td>
<td>153.8</td>
<td>117.6</td>
<td>115.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Percent Not Target within 48 hours</td>
<td>25.8</td>
<td>4.6</td>
<td>3.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Percent &lt;40</td>
<td>0</td>
<td>0</td>
<td>0.16</td>
<td>0.9006</td>
</tr>
<tr>
<td>Percent &lt;70</td>
<td>1.14</td>
<td>1.42</td>
<td>1.94</td>
<td>0.2581</td>
</tr>
<tr>
<td>Percent &gt;180</td>
<td>22.9</td>
<td>5.8</td>
<td>3.3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Percent &gt;250</td>
<td>4.5</td>
<td>0.12</td>
<td>0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean Hours to Target BG</td>
<td>22.1</td>
<td>8.7</td>
<td>5.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean Hours to 1st BG 80–120 mg/dL</td>
<td>14.3</td>
<td>5.6</td>
<td>3.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Hyperglycemic Index (HGI) mg/dL</td>
<td>41.34</td>
<td>12.97</td>
<td>8.46</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Percent Hours at Target</td>
<td>54%</td>
<td>82%</td>
<td>96%</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Comparison of BG outcomes, IVI pre-protocol (with type 2 diabetes) and IVIIC post-protocol (with type 2 diabetes and without type 2 diabetes)

Outcomes of a Nursing Survey to Evaluate the Success of a Web-based Intravenous Insulin Infusion Protocol in a University Hospital
Cory R. White, Barbara Wojciechowski, Timothy V. Hushion, Pamela C. Arnold, Lisa Kozlowski, Kathie L. Hermayer

ABSTRACT

Many insulin infusion protocols are available for clinical use. We developed a web-based on-line intravenous insulin infusion calculator (IVIC) for use in our intensive care and medical-surgical units. The IVIC is programmed to resemble an algorithm such that any patient requiring intravenous insulin (IVI) is started on IVI with an insulin sensitivity factor, a multiplier of 0.3. The calculator uses the following mathematical formula: rate of insulin in milliunits/hour= (current blood glucose (BG) - 60 mg/dl) x 0.03. This requires hourly BG checks to maintain BG levels 80-110 mg/dl.

In September 2006 we implemented a quality improvement project, an on-line survey to evaluate the acceptance of this protocol by the nursing staff. Of 105 Registered Nurses (RNs) who participated, there was no difference in the experience level of the RNs (>= or < 5 years) or in the time in which they had been working on their unit (>= or < 2 years).

It was very important to educate the nurses and key medical personnel regarding use of the IVIC protocol(3). Many in-service sessions were conducted to outline the protocol and troubleshoot any difficulties(4,5).

INTRODUCTION

Choosing an optimal intravenous insulin (IVI) protocol involves much consideration. There is great concern about a heightened burden on nursing workload due to increasing the frequency of BG checks. The cost involved in purchasing and implementing a pre-existing computerized IVI protocol is paramount. A great deal of time and commitment is involved in networking and training in the implementation of a housewide IVI(1). There is an element of acceptance and buy-in by the medical staff regarding an IVI to overcome a generalized attitude of resistance to change and fear of hypoglycemia. Lastly, a computer-based system needs to be continually updated to evaluate outcomes of glycemic control and safety(2).

SUBJECTS AND METHODS

In September 2006 we implemented a quality improvement project, an on-line survey to evaluate the acceptance of this protocol by the nursing staff in the ICU’s and medical-surgical units. This study was approved by our Institutional Review Board and the need for informed consent was waived. Of 105 Registered Nurses (RNs) who participated, there was no difference in the experience level of the RNs (>= or < 5 years) or in the time in which they had been working on their unit (>= or < 2 years).

Approximately 25% (p=0.005) of the nurses felt the training was adequate. Significantly less than 25% (p=0.022) of the nurses (18%) felt it was necessary to go off the protocol. Reasons for going off the protocol included using supplemental medications in D5W or using bolus tube feedings. Over 85% (p=0.003) of the nurses believed the ability to make changes at their level of practice 69% (p=0.05). In summary, the IVIC is well accepted by nurses for care of hyperglycemia in a hospital setting.

RESULTS

Approximately 25% (p=0.005) of the nurses were using the protocol for the first time (65.1%) and about half of the nurses had prior knowledge of the protocol (48.5%). The nurses were surveyed regarding the use of and interpretation of the protocol, their comfort level, confidence in, and experience in using the protocol. Over 80% of the nurses found the protocol easy to implement (p=0.001), easy to interpret (p=0.001), and successful in controlling the blood glucose levels (p=0.012). Approximately 71% (p=0.001) of the nurses were comfortable with the tight blood glucose levels of the protocol. The nurses’ confidence level with the protocol was 82% (p=0.001).

NURSING QUESTIONNAIRE

The authors wish to acknowledge the MUSC Diabetes Center for financial support of this project.
**Key Points: IV Insulin Infusions**

- Prime the line and waste an additional 20ml
  - Saturation of polyvinyl tubing.
- 1:1 ratio (i.e., 100 units insulin mixed 100 ml solution).
- If patient eats a meal and is still on IV Insulin drip, give prandial insulin to cover the meal
  - If patient has no history of diabetes prior to admission and is ‘hyperglycemic’ start with a low prandial insulin dose:
    - Example, give 3 units if patient eats > 50% CHO for meal.
- Transitioning off insulin drip
  - Overlap basal insulin and IV Insulin Infusion by 2 hours.
  - Transition at a time that NPH or glargine should be given – breakfast and/or bedtime.

Evaluation of Ward Management of Diabetic Ketoacidosis

Branden D. Nemecek, PharmD, Kathie L. Hermayer, MD, MS, Pamela C. Arnold, MSN, and Nicole M. Bohm, PharmD

Volume 32, Number 3, 2014 • CLINICAL DIABETES
CO-ADMINISTRATION OF SQ INSULIN GLARGINE WITH INSULIN INFUSION IN THE ACUTE MANAGEMENT OF DKA

- **Start glargine (basal) insulin with IV Insulin Infusion:**
  - Studies differed in dose (0.25, 0.3, 0.4 Units/kg).
  - Studies differed in timing SQ glargine (2, 3 or 12 hours).
  - No difference in:
    - amount of IV infusion, anion gap closure, hypoglycemia events or LOS.
  - In 2 studies, significantly less rebound hyperglycemia at either 12 or 24 hours after infusion.
  - Non-significance in time to DKA recovery and LOS may be explained by small sample sizes.
  - Demonstrated relative safety and effectiveness in using long-acting analogue during intravenous insulin infusion.
  - Hospitals should have a standard protocol for discontinuing an insulin infusion.

- Bunn et al. AJCC, May 2016 (review of Houshyar, Doshi, Hsia).
HOSPITAL HYPOGLYCEMIA

- Occurs in 35-42% of patients with Type 1 diabetes.
- Higher rates of severe hyperglycemia if longer duration of diabetes:
  - >15 years vs. >5 years: rates of 46% vs. 22%
- Cause of significant loss of productivity and hospital stays.

Cryer, 2009.
# Hypoglycemia

Plasma glucose of $\leq 70$ mg/dL ($\leq 3.9$ mmol/L) in patients

<table>
<thead>
<tr>
<th>Classification</th>
<th>Features</th>
<th>Glucose value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe hypoglycemia</td>
<td>An event requiring assistance of another person</td>
<td>Neurological recovery after glucose returns to normal</td>
</tr>
<tr>
<td>Documented symptomatic hypoglycemia</td>
<td>Typical symptoms of hypoglycemia</td>
<td>$\leq 70$ mg/dL</td>
</tr>
<tr>
<td>Asymptomatic hypoglycemia</td>
<td>No typical symptoms</td>
<td>$\leq 70$ mg/dL</td>
</tr>
<tr>
<td>Probably symptomatic hypoglycemia</td>
<td>Typical symptoms</td>
<td>Presumed to be $\leq 70$ mg/dL</td>
</tr>
<tr>
<td>Pseudo-hypoglycemia</td>
<td>Typical hypoglycemic symptoms</td>
<td>Glucose $&gt;70$ mg/dL but approaching that level</td>
</tr>
</tbody>
</table>

Seaquist, 2013.
## Hypoglycemia Symptoms

<table>
<thead>
<tr>
<th>Adrenergic Symptoms</th>
<th>Neuroglycopenic Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallor</td>
<td>Confusion</td>
</tr>
<tr>
<td>Diaphoresis</td>
<td>Slurred Speech</td>
</tr>
<tr>
<td>Shakiness</td>
<td>Irrational behavior</td>
</tr>
<tr>
<td>Hunger</td>
<td>Disorientation</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Loss of consciousness</td>
</tr>
<tr>
<td>Irritability</td>
<td>Seizures</td>
</tr>
<tr>
<td>Headache</td>
<td>Pupillary Sluggishness</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Decreased response to noxious stimuli</td>
</tr>
</tbody>
</table>

Kalra, 2013.
**Hypoglycemia Risk Factors**

- Strict glycemic control.
- Mismatch of insulin timing or amount with carbohydrate intake.
- History of severe hypoglycemia.
- Sleep/general anesthesia or other sedation.
- Duration of diabetes and age.
- Reduced oral intake.
- Impaired awareness of hypoglycemia.
- C-peptide negativity.
- Critical illness.
- Unexpected travel after rapid-acting insulin.

*Kalra, 2013.*
Hypoglycemia Risk Factors

- Endocrine deficiencies:
  - Hypothyroidism, hypopituitarism, primary adrenal insufficiency, growth hormone deficiency.
- Sudden reduction in corticosteroid dose.
- Emesis/vomiting.
- Reduced IV dextrose administration.
- Interruption of enteral feedings or TPN.
- Drug dispensing error.
- Renal and hepatic dysfunction.

Kalra, 2013.
Hypoglycemia Outcomes

- Functional brain failure reversed by correction of glucose levels.
- Prolonged hypoglycemia can cause brain death.
- Long term cognitive effects seen in children (< 5, particularly vulnerable).
- Increased dementia, cerebral ataxia, cognitive problems in elderly.
- Glucose reperfusion in rat studies suggest that extreme hyperglycemia after hypoglycemia may contribute to neuronal death.

HYPOGLYCEMIA OUTCOMES

- Hypoglycemia may lead to sudden cardiac death from arrhythmia.
- “Dead in bed” syndrome: death in young Type 1 patients likely due to prolonged QT and arrhythmia (Accounts for 5-6% of deaths in this demographic).
- Increase mortality in ACCORD (Action to Control Cardiovascular Risk in Diabetes) study in intensive group (goal a1C <6.5%) and 3 fold higher incidence of hypoglycemia.

Hypoglycemia Unawareness

- Loss of adrenergic symptoms prior to onset of neuroglycopenic symptoms.
- Hypoglycemia-associated autonomic failure (HAAF):
  - Defective counter-regulatory decrease in insulin and increase in glucagon and attenuated epinephrine release.
  - May be reversed at least partially by avoidance of hypoglycemia, is maintained by recurrent hypoglycemia.
  - 25-fold increased risk of severe hypoglycemia during intensive diabetes management.

Seaquist 2013; Moheet 2013.
Figure 1—Mechanisms by which hypoglycemia may affect cardiovascular events. Hypoglycemic events may trigger inflammation by inducing the release of C-reactive protein (CRP), IL-6, and vascular endothelial growth factor (VEGF). Hypoglycemia also induces increased platelet and neutrophil activation. The sympathoadrenal response during hypoglycemia increases adrenaline secretion and may induce arrhythmias and increase cardiac workload. Underlying endothelial dysfunction leading to decreased vasodilation may also contribute to cardiovascular risk.
**Inpatient Hypoglycemia is Associated with Increased Morbidity/Mortality** (4368 admissions of 2582 patients with DM on general ward; hypoglycemia: BG < 50 mg/dL)

**Inpatient Mortality**

*Hypoglycemia and inpatient outcomes*

Figure 2 — Lowest blood glucose and inpatient mortality. The lowest blood glucose level recorded during the hospital stay was plotted against the fraction of patients who died during the admission for 338 patients who had at least one hypoglycemic episode documented in the hospital. Bars indicate 95% CI. The number of admissions in each category is given in parentheses.

**Post discharge Mortality**

*Fraction Deceased at 1 Year*

Figure 1 — Frequency of hypoglycemia and 1-year mortality. Bars indicate 95% CI. The number of admissions in each category is given in parentheses.

- 7.7% prevalence of hypoglycemia
- Inpatient hypoglycemia was strongly correlated with inpatient and Post discharge death and increased LOS

**Inpatient LOS**

*Change from Expected LOS, days*

Figure 3 — Frequency of hypoglycemia and length of hospital stay. Bars indicate SEM. The number of admissions in each category is given in parentheses.

Nocturnal Hypoglycemia and Cardiac Arrhythmia evaluated by continuous EKG and CGMS in T1DM (n=25)

- Sinus bradycardia following 35 min of BG < 40 mg/dL
- Prolonged QT followed by Multifocal ventricular ectopic Beats Following BG 52-58 mg/dL
- Variable P wave structure With BG 41 mg/dL

Medical University of South Carolina
Hypoglycemia
Standing Order/Protocol
**History of Adult Hypoglycemia Treatment**

**Fast 15 is now Fast 16!**

D50 (1/2 – 1 amp); now all aliquots of D50 to prevent rebound hyperglycemia.

**JC Standard of recheck POC BG w/30 minutes of 1st POC BG <70mg/dL or within 20 minutes of treatment.**

Identification high risk patients, documenting reasons & opportunities for improvement, staff RN diabetes nursing assessment questions on admission.
# Hypoglycemia Prevention and Treatment Standing Order

**PHYSORDER**

**Adult Hypoglycemia Prevention and Treatment STANDING Order**

*ORDERS APPROVED FOR USE BY MEDICAL DIRECTOR*

**Page 1 of 2**

Form Origination Date: 10/04
Version: 8
Version Date: 9/11

**ALLERGIES/DRUG SENSITIVITY:**

1. 
2. 
3. 
4. 

**PATIENT IDENTIFICATION LABEL**

- **Patient Name:** 
- **MRN:** 

**Weight:** ____________ **kg**

**Height:** ____________ **cm**

---

1. **Identify the following patients as “Risk for Hypoglycemia”:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 DM</td>
<td>Liver Disease</td>
</tr>
<tr>
<td>Type 2 DM</td>
<td>Sepsis</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>Shock</td>
</tr>
<tr>
<td>HHNK</td>
<td>Stroke</td>
</tr>
<tr>
<td>DKA</td>
<td>CHF</td>
</tr>
<tr>
<td>CF related DM</td>
<td>Alcoholism</td>
</tr>
<tr>
<td>Pancreatic dysfunction</td>
<td>Burns</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>Sudden AMS</td>
</tr>
<tr>
<td>Hypoglycemia unawareness</td>
<td>ESRD</td>
</tr>
</tbody>
</table>

Medications known to cause Hypoglycemia: [non-selective beta blockers, conivaptan, ethacrynic acid, fluoroquinolones, octreotide, pentamidine, quinine, ACE inhibitors, and sulfa-methoxazole (when dose not adjusted for renal impairment)]

2. **Treat hypoglycemia based on patient characteristics and interventions described in Adult Hypoglycemia Protocol (page 2)**
3. Nursing to monitor **Point of Care Testing Blood Glucose (POCT BG)** PRN as determined by nursing assessment if hypoglycemia is anticipated or if patient is awaiting surgery.

4. Due to a patient’s risk for a repeated hypoglycemia event during the 24 hours after the initial event, **POCT BG** monitoring to be PRN as determined by nursing assessment.

5. ✗ Give 4 glucose tablets (4 gm/tablet) PO per hypoglycemia protocol (Tablets may be chewed or crushed for NG use)

6. ✗ Administer dextrose 50% by intravenous push as per hypoglycemia protocol

7. ✗ Administer glucagon intramuscularly as per hypoglycemia protocol

8. If the patient has a change to their nutritional status or procedure schedule AND has received insulin within the previous 8 hours: Contact the physician on call for further orders.

9. If the patient has 2 severe hypoglycemic events (less than 50 mg/dL), start a D10W infusion at 50 mL/h X 2 hours: Contact the physician on call, after start of the infusion, for further orders.

10. If the patient is on continuous enteral tube feeds and insulin AND a short or long term interruption of the tube feed occurs, administer 10% dextrose IV fluids at the same rate as the previous tube feeds and contact physician for further orders.

11. Nurse to document all medications and other interventions in Admin Rx, Clin Doc or “DIABETES Monitoring and Insulin MAR Flowsheet form”.

HYPOGLYCEMIA PREVENTION AND TREATMENT STANDING ORDER

"PHYSORDER"
Adult Hypoglycemia Prevention and Treatment
STANDING Order
(ORDERS APPROVED FOR USE BY MEDICAL DIRECTOR)

Form Origination Date: 10/04
Version: 8

IS NOT TO BE SAVED with patient information. Selecting the PRINT button will clear all information from the note.

Patient Name
MRN

PATIENT IDENTIFICATION LABEL

ADULT HYPOGLYCEMIA PROTOCOL:
Sequence of interventions:
1. Initiate adult hypoglycemia protocol: Non-Pregnant patients blood glucose less than 70 mg/dL.
2. Initiate adult hypoglycemia protocol: Pregnant patients blood glucose less than 60 mg/dL.
3. Treat hypoglycemia using the following table:

<table>
<thead>
<tr>
<th>PATIENT CHARACTERISTICS</th>
<th>ACTION TO BE TAKEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient is unable to eat or swallow safely</td>
<td>1. Administer dextrose 50% by intravenous push as follows: 15 mL (7.5 grams) for blood glucose 60 mg/dL – 69 mg/dL 20 mL (10 grams) for blood glucose 50 mg/dL – 59 mg/dL 25 mL (12.5 grams) for blood glucose 30 mg/dL – 49 mg/dL 30 mL (15 grams) for blood glucose less than 30 mg/dL</td>
</tr>
<tr>
<td>The patient is NPO</td>
<td>2. Assess unconscious patient for adequate airway, breathing, and circulation</td>
</tr>
<tr>
<td>Or</td>
<td>3. If possible, place patient in a lateral recumbent position to decrease aspiration risk</td>
</tr>
<tr>
<td>The patient is unconscious</td>
<td>4. Place patient on seizure precautions</td>
</tr>
<tr>
<td>And</td>
<td>5. Re-check blood glucose within 30 minutes and repeat treatment every 30 minutes until blood glucose is greater than 70 mg/dL</td>
</tr>
<tr>
<td>The patient HAS INTRAVENOUS ACCESS</td>
<td>6. Re-check consciousness for blood glucose &lt; 40 mg/dL</td>
</tr>
</tbody>
</table>
## Hypoglycemia Prevention and Treatment Standing Order

**The patient is unable to eat or swallow safely**
- The patient is NPO
- Or
- The patient is unconscious
- And
- The patient **DOES NOT HAVE INTRAVENOUS ACCESS**

1. Administer 1 mg glucagon intramuscularly
2. Assess patient for adequate airway, breathing, and circulation
3. Place patient in a lateral recumbent position to decrease aspiration risk
4. Place patient on seizure precautions
5. Establish intravenous access
6. Re-check blood glucose within 30 minutes and repeat treatment every 30 minutes until blood glucose is greater than 70 mg/dL
7. Re-check consciousness for blood glucose < 40 mg/dL

**The patient **IS ABLE TO EAT AND SWALLOW** safely**
- Or
- The patient has a patent naso-gastric tube

1. Feed with 16 grams of carbohydrate in order of preference from the following:
   - 4 glucose tablets
   - 1 tablespoon of sugar (3 packets)
   - 4 oz (120 mL) of regular soda
   - 4 oz (120 mL) of juice
2. Re-check blood glucose within 30 minutes and repeat treatment every 30 minutes until blood glucose is greater than 70 mg/dL.
3. It will be necessary to give the patient extra food after blood glucose is greater than 70 mg/dL if hypoglycemia occurs greater than one hour from meal or occurs during sleeping hours. Feed the patient one of the following:
   - 8 oz (1 cup) of whole milk
   - 6 saltine crackers with 2 tablespoons of peanut butter
   - 6 saltine crackers with 1 oz cheese
   - 1 package of cheese or peanut butter nabs

4. Call the physician after treatment has been administered.
5. Document treatment and reason in ClinDoc 24 hr record or paper DIABETES Monitoring and Insulin MAR Flowsheet form.
6. Check the patient for hypoglycemia symptoms every 60 minutes until a meal is consumed or a physician
MUSC EMR Intervention: NPO Prevention of Hypoglycemia

Care Guidance (1 Advisory)

An NPO order is being placed and the patient has had an active order for basal insulin within the last 24 hours.

Consider using the order set below in an effort to prevent hypoglycemia.

Provider to consider decreasing or discontinuing basal and prandial insulin orders.

- If patient received basal insulin within the last 12 hours (NPH) or 24 hours (glargine):
  - Initiate dextrose fluid AND Q1H blood glucose checks.
  - Dextrose fluid infusion options
  - Check blood glucose Q1H until 70-180 mg/dL x 3 hours
    - Routine, Every hour First occurrence Today at 1600 Until Specified
    - When blood glucose is 70-180 mg/dL, Q1H x 3 hours, glucose checks can transition to Q4H. If blood glucose < 70 mg/dL, or > 180 mg/dL x 2 consecutive checks, contact prescriber.

- If patient has type 1 diabetes:
  - 

- If patient has type 2 diabetes:
  - 

Order Sets

NPO Hypoglycemia Prevention Manage My Version

Add Order
TREATMENT OF HYPOGLYCEMIA IN HOSPITALIZED PATIENTS

Descriptive Study:

- 210 patients (105 from 2 Midwestern Hospitals; one 370-bed non-teaching, one 450-bed teaching).

- Total of 484 episodes of hypoglycemia were analyzed for adherence to the 5 steps of practice guidelines found in the respective hospital policy manuals.

Anthony, Maureen; The Diabetes Educator 2007; 33; 709-715.
5 Components Hypoglycemia Treatment Guideline

1. Administration of 15g of CHO’s
2. BG retest performed in 15 minutes
3. BG retest performed 1 hour after hypoglycemia resolved
4. Physician notified
5. Hypoglycemia event documented in the patient record

Anthony, Maureen; The Diabetes Educator 2007; 33; 709-715.
## RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Hospital A</th>
<th>Hospital B</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG range</td>
<td>24-69</td>
<td>20-69</td>
</tr>
<tr>
<td>Patients Correct CHO</td>
<td>17% (34)</td>
<td>3% (9)</td>
</tr>
<tr>
<td>Episodes tx more CHO</td>
<td>18% (36) 30-70g</td>
<td>39% (112) 24-70g</td>
</tr>
<tr>
<td>Tx too little</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>Cases no documentation</td>
<td>43%</td>
<td>28%</td>
</tr>
<tr>
<td>Doc. in nurses notes</td>
<td>54% (106)</td>
<td>71% (205)</td>
</tr>
<tr>
<td>MD notified &amp; doc</td>
<td>15% (30)</td>
<td>28% (83)</td>
</tr>
<tr>
<td>Episodes amt not spec.</td>
<td>18% (36)</td>
<td>30% (87)</td>
</tr>
<tr>
<td>F/U 10-20 min patients</td>
<td>9% (17)</td>
<td>6% (17)</td>
</tr>
<tr>
<td>F/U episodes 50-70min</td>
<td>25% (49) *5% (10)</td>
<td>16% (47) *2% (6)</td>
</tr>
</tbody>
</table>

Anthony, Maureen; The Diabetes Educator 2007; 33; 709-715.
IMPLICATIONS

- **Low** adherence to hypoglycemic treatment guidelines.
- **Not a single case** of adherence to all 5 steps at either study hospital identified in the policy.
- **Critical** that all care providers become competent in basic diabetes management.

Anthony, Maureen; The Diabetes Educator 2007; 33; 709-715.
**Insulin Pumps in the Hospital**

- MUSC patient agreement.
- Joint Commission Standards:
  - Insulin pump competency assessment
    - Determined by the adult or pediatric diabetes teams
      - MD, mid-level provider or CDE
  - Insulin pump order set.
  - Insulin pump site documentation and all tubing and site changes.
Continuous Subcutaneous Insulin Pump Therapy
Patient Agreement

Date: 
Time: _____ hrs

MUSC does not discourage a patient’s right to use their own insulin pump as long as such use does not interfere with the patient’s prescribed treatment plan or compromise their current clinical condition. The MUSC Medical Center does not take responsibility for the insulin pump or pump accessories from either a repair or replacement standpoint.

MUSC Medical Center asks that you read the following list of promises about you using your own insulin pump while you are here. These promises will help with giving you the best care, as well as keeping you as safe as possible. If you think that you cannot keep any or all of these promises, then we would like to care for your diabetes with insulin injections and we would ask that you stop using your insulin pump while you are here.

During my hospital stay, I promise:
1. To show my nurse the bolus rate in the pump. I will not change any of the basal rates unless directed by a doctor’s order and in the presence of my nurse.
2. To show my nurse all Prandial and Correction doses that I am taking after my FSBG is checked, as needed.
3. To allow MUSC staff to check my FSBG with MUSC’s equipment unless a comparison test of my glucometer and MUSC’s equipment results in a difference of 20% or less.
4. To change the infusion set every 48 – 72 hours or as needed for:
   a. Skin problems, or
   b. Two FSBG readings in a row of greater than 275 mg/dL.
5. To provide all tubing, hubs, and equipment for my pump.
6. To report any signs of low blood sugar to my nurse immediately.
7. To keep the flow sheet at my bedside up to date and to show my nurse the total daily insulin doses.
8. To report any problems with my pump to the nurse.
9. To ask questions about the use of my pump or the doctor’s orders.
10. To have a family member, friend, or significant other to assist me and the MUSC staff with the operation of my pump if I cannot manage the use of my pump by myself. This person will stay with me in the hospital at all times during my stay. The pump will be disconnected if the person cannot stay. The individual staying with me will be responsible for their own incidental expenses (e.g., meals) and MUSC may not be able to provide any personal items (i.e., cot, sheets, pillows, blankets, etc.) for sleeping in the patients’ rooms.

I also agree and understand that the pump may disconnected and another way of delivering insulin may be used for the following reasons:
1. Doctor’s Orders
2. Changes in level of awareness or consciousness
3. Surgery or procedure such as X-Rays that require me to be disconnected
4. Other reasons that are based on the decisions of the medical staff
5. Changes in my judgment
6. My nurse does not agree
7. Changes in my condition

I have been given a chance to ask questions about this agreement and they have been answered to my satisfaction. If I have further questions about the use of my pump while at MUSC, I may contact my attending physician, ____________________.

Patient Signature ___________________________ Date _____________
Family Member (et al.) Signature ___________________________ Date _____________
Witness Signature ___________________________ Date _____________

insulinpumpagreement
# Assessment for Competency to Self-Administer Subcutaneous Insulin via Insulin Pump

**Patient Name**

**MRN**

**Patient Identification Label**

---

**Form Origination Date:** 8/06

**Version:** 2

---

**Version Date:** 10/09

---

**Compétency assessment to be completed only by CDE / Midlevel Provider of the Adult or Pediatric Endocrine Team for on-going capability to self-administer subcutaneous insulin via insulin pump:**

**Must answer YES to all statements to be considered competent.**

<table>
<thead>
<tr>
<th>Statement</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Patient is alert and oriented to person, place and time.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Patient is not on suicide watch or precautions.</td>
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<td>3. Patient is able to demonstrate bolus rate via pump.</td>
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<td>4. Patient able to demonstrate basal rate via pump.</td>
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<td>5. Patient or family able to furnish all insulin pump supplies.</td>
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<td>6. Patient or family member is competent in infusion site changes.</td>
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<td>7. If patient cannot manage pump on their own, then family member agrees to manage the pump at all times.</td>
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<td>8. Patient aware of 1-800-XXX-XXXX number on back of pump for troubleshooting purposes.</td>
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<td>9. Patient is aware of the need to take off pump for any radiology procedure.</td>
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<td>10. Patient is aware if they take off pump, they need to store it in a safe, secure place so as to not get lost or stolen.</td>
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<td>11. Patient is aware if blood glucose unexpectedly rises, then check infusion site, tubing and battery.</td>
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<td>12. Patient is not requiring surgery.</td>
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<tr>
<td>13. Patient (family member) agrees to inform nurse of bolus insulin dose when given.</td>
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</table>

**All Assessment Answers must be YES**

If **at any time** the patient is **not alert and oriented to person, place and time**

**OR**

the **patient's family member, friend or significant other** who agrees to be responsible for monitoring insulin pump regimen while the patient is hospitalized is **not available** contact physician and chart this in the 24 hour patient record.

---

**Signature / Credentials**

**Pager ID**

**Date**

**Time**

**AM/PM**

---

**all_dncu_selfadministerinsulincompetency**

---

**OTE 900429 Rev. 10/09**
1. Discontinue all previous insulin orders
2. Diagnosis(es):
3. Allergies and Sensitivities:

4. Insulin: □ insulin aspart (NovoLOG®) 10 mL (100 units/mL). Pharmacy to supply 10 mL vial for patient.
   □ Other: to be delivered subcutaneously by a(n) __________ insulin pump, as managed by the patient or family member, according to the following parameters:

   A. Basal insulin:

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   Basal insulin (in the appropriate amount) is the insulin needed to maintain a constant glucose level that is not related to the food eaten.

B. Prandial (meal time) insulin: □ Insulin to carbohydrate ratio ___ unit(s) per ___ grams of CHO
   □ Scheduled: breakfast ___ units, lunch ___ units, dinner ___ units

C. Correction insulin: □ (one unit lowers Point of Care Testing Blood Glucose (POCT BG) ___ mg/dL)
   Correct to POCT BG of ___ mg/dL

Physician Signature ___________________________ Pager ID ____________ Date ____________ Time ____________ AM/PM

insulinpumpself

OTE 900423 Rev. 9/11
**Self Management Flowsheet**

for Inpatient

**Continuous Subcutaneous Insulin Infusion**

(Insulin Pump)

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* MUSC MEDICAL UNIVERSITY OF SOUTH CAROLINA

Form Origination Date: 9/06
Version: 1

MRN
STAMP PLATE AREA

OTE 900430 9/06
Hospital Guidelines for Diabetes Management and the Joint Commission-American Diabetes Association Inpatient Diabetes Certification

Pamela Arnold, MSN, Danielle Scheurer, MD, MSCR, Andrew W. Dake, MD, Angela Hedgpeth, BSN, Amy Hutto, BSN, Caroline Colquitt, MS and Kathie L. Hermayer, MD, MS
SUMMARY

- Discussed the ADA/AACE Recommendations for In-Patient Glycemic Control.
- Identified importance of healthcare providers understanding insulin concepts (basal, prandial and correction) as well as insulin timing.
- Discussed the evidence & role IV Insulin Infusion protocols in the hospital.
- Examined hypoglycemia including:
  - Like hyperglycemia, hypoglycemia appears to be a pro-inflammatory and arrhythmogenic state.
  - Likely a marker for “sicker” patients, but should still be avoided.
  - Using evidence-based protocols, standardization of glucose management, introducing hypoglycemia avoidance strategies will likely minimize events.
  - The role of hypoglycemia on outcomes needs further study and likely varies based on the specific patient population.
  - Hypoglycemia is Dangerous!
- Hospital diabetes management takes administrative support and a knowledgeable team!
- JC Inpatient Certification is doable!
QUESTIONS