Meeting Your Patient’s Insulin Needs Through Transitions of Care

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Disclosures

• Stuart T. Haines is President of Rx Instructional Systems Inc, consultant to ASHP Advantage, and Director for the APhA Foundation
• Jennifer Trujillo has served on advisory boards for Sanofi US and BD.

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Learning Objectives

1. Apply national guidelines to the establishment of blood glucose goals for patients with diabetes in various practice setting.
2. Recognize common attitudes among patients with diabetes that contribute to resistance to insulin therapy.
3. Provide patient education to increase acceptance of insulin therapy.
4. Describe strategies for managing insulin requirements during transitions of care.
5. Explain how to manage patients using insulin pumps during transitions of care.

Which of the following statements most accurately describes the clinical evidence related to intensive glycemic control in the hospital setting?

A) Most studies have shown that tight glycemic control reduces mortality without increasing rates of hypoglycemia
B) Most studies have shown that tight glycemic control reduces mortality but increases rates of hypoglycemia
C) Most studies have been conducted in the general medicine (non-ICU) patient population
D) Studies have been unable to reproduce the positive results seen in the initial landmark study.

Target Audience: Pharmacists

ACPE#: 0202-0000-16-067-L01-P

Activity Type: Application-based
According to the AACE/ADA as well as the Endocrine Society guidelines, which of the following is the recommended fasting blood glucose goal for most hospitalized patients in a non-ICU setting?

A. 70-110 mg/dL  
B. <120 mg/dL  
C. <140 mg/dL  
D. 140-180 mg/dL

Ms. Jones has stated that she does not want to start insulin. Her A1c is 9.3%. Which of the following strategies is most likely to increase her acceptance of basal insulin therapy and persistence with treatment?

A. Clearly state to Ms. Jones the potential harms of refusing to take insulin therapy.  
B. Explain to Ms. Jones that modern needles are very small and practically painless.  
C. Allow Ms. Jones to self-titrate the insulin dose to a specific fasting glucose target range.  
D. Enlist a family member to reinforce (daily) the importance of taking insulin to prevent future complications.

Which of the following insulin management strategies has been shown to reduce the risk of both hyperglycemia and hypoglycemia in hospitalized patients in non-ICU settings?

A. Continue metformin therapy in combination with insulin therapy throughout the hospital stay.  
B. Provide bolus doses of insulin based on a sliding scale when the BG measurement is > 140 mg/dL.  
C. Provide a daily basal dose of long-acting insulin (0.25 units/kg) and correction doses based on a sliding scale.  
D. Use an insulin infusion – either intravenous or subcutaneous – and adjust the infusion rate every 2-4 hrs.

A patient wearing an insulin pump in hospital has a BG reading of 123 mg/dL prior breakfast (7am), 197 mg/dL prior to lunch (12:30pm), and 296 mg/dL at 3pm despite a larger than usual bolus dose with lunch. Which of the following would be the most appropriate action to take?

A) Inspect the pump, tubing, and insertion site  
B) Increase her insulin:carb ratio and sensitivity factor by 20%  
C) Instruct the nursing staff to check her blood glucose more frequently  
D) Discontinue pump therapy and initiate insulin glargine 20 units QHS and insulin aspart 10-15 units prior to meals

**CASE #1**

LT is a 59 year old African American male  
HPI: Admitted to hospital today with right lower lobe community acquired pneumonia  

Presents to the Emergency Department complaining of a 3-day history of fever, cough, and RLL pneumonia on chest x-ray
Case #1

Past Medical History:
- Diabetes Type 2 x 9 years
- Hypertension x 7 years
- Dyslipidemia x 7 years

Home Medications:
- Metformin 1000mg PO twice daily
- Liraglutide 1.8mg SC daily
- Lisinopril 20mg PO daily
- Amlodipine 10mg PO daily
- Rosuvastatin 10mg PO daily

Case #1

Social & Family Hx:
- Resides with wife
- Works as a delivery driver
- Walks 3 times per week for 30 minutes
- Eats out for lunch frequently, has lost 10 pounds in the last year
- Does not smoke tobacco or use illicit drugs
- Does not drink alcohol
- Father died from renal failure
- Mother died from CVD

Glucose Control History:
- A1C 7.4% (4 months ago)
- SMBG 3-4 times per week before breakfast and occasionally 2 hours after dinner
  - Fasting 30-day average = 163 mg/dL (range 138-174 mg/dL)
  - Post-meal 30-day average = 202 mg/dL (range 169-256 mg/dL)
- No episodes of hypoglycemia in the last month
- He reports that his glucose levels have been higher over the past few days

Case #1

Vital Signs:
- BP = 138/78   Pulse = 88, regular
- Weight = 198 lbs  Height = 5' 9"
- BMI = 29   Temp = 101

Labs (drawn in ED):
- Glucose = 312 mg/dL   A1c = 8.7%
- BUN = 20   Scr = 1.3  eGFR = 67 ml/min
- Na = 126   K = 4.7  WBC = 13.2

Case #1

Admission Medications:
- Lisinopril 20mg PO daily
- Amlodipine 10mg PO daily
- Rosuvastatin 10mg PO daily
- Levofloxacin 500mg IV q24h
- Sliding scale insulin every 6 hours
  For BG  Give regular insulin
  <150 none
  150-200 2 units
  201-250 4 units
  251-300 6 units
  301-350 8 units
  > 350 Call physician

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Which of the following would be the most appropriate next step in terms of managing LT's (this patient’s) hyperglycemia?

A) Continue his metformin and liraglutide and initiate regular insulin sliding scale
B) Continue his metformin and liraglutide and initiate a basal-bolus insulin regimen
C) Discontinue his metformin and liraglutide and initiate regular insulin sliding scale
D) Discontinue his metformin and liraglutide, and initiate a basal-bolus insulin regimen

Which of the following pre-meal glucose goals would be most appropriate to target during this patient’s hospital stay?

A) < 110 mg/dL
B) 70 – 130 mg/dL
C) < 140 mg/dL
D) 140 – 200 mg/dL

Which of the following statements most accurately describes the clinical evidence related to intensive glycemic control in the hospital setting?

A) Most studies have shown that tight glycemic control reduces mortality without increasing rates of hypoglycemia
B) Most studies have shown that tight glycemic control reduces mortality but increases rates of hypoglycemia
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D) Studies have been unable to reproduce the positive results seen in the initial landmark study.

Hyperglycemia prevalence in the hospital

A common comorbidity in medical-surgical patients

- Normoglycemia
- Known Diabetes
- New Hyperglycemia

N=2,020; hyperglycemia: FBG > 126 mg/dL or random BG > 200 mg/dL x 2


Hyperglycemia in the Hospital

- Defined as an admission or in hospital BG > 140 mg/dL
- Implementation of A1C testing is useful:
  - Assess glycemic control prior to admission
  - Differentiate newly diagnosed diabetes from stress hyperglycemia
  - A1C ≥ 6.5% can be identified as diagnosis of diabetes
  - Design an optimal regimen at time of discharge

Risks associated with hyperglycemia in hospital

- Increased risk of mortality
- Longer length of stay
- Higher admission rates to ICU
- Greater risk of infection
- Impaired wound healing
- Higher likelihood that transition to nursing home care after discharge will be required
Historical Context

10-20 years ago: Inpatient hyperglycemia not a priority.
Sliding scale insulin used predominantly.

2004: First treatment goals published. ADA and AACE convene consensus conference.

2006: ADA and AACE publish "call to action" and recommend strategies to overcome barriers.

2005: ADA included inpatient glycemic control in annual standards of care.

2006-2009: Several studies show inconsistent results, questioning benefits and highlighting risks of tight control.

2009: ADA and AACE publishes new consensus statement with revised glucose targets.

Target Glucose Levels in the Hospital

<table>
<thead>
<tr>
<th>Organization</th>
<th>Glucose target in non-ICU setting</th>
<th>Glucose target in ICU setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>AACE/ADA</td>
<td>Pre-meal &lt; 140 mg/dL Random &lt; 180 mg/dL</td>
<td>140-180 mg/dL</td>
</tr>
<tr>
<td>Endocrine Society</td>
<td>Pre-meal &lt; 140 mg/dL Random &lt; 180 mg/dL</td>
<td>--</td>
</tr>
<tr>
<td>American College of Physicians</td>
<td>--</td>
<td>140-200 mg/dL</td>
</tr>
</tbody>
</table>

Target Glucose Levels in the Outpatient Setting

<table>
<thead>
<tr>
<th>Organization</th>
<th>A1C</th>
<th>FPG (mg/dL)</th>
<th>PPG (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADA</td>
<td>&lt; 7%</td>
<td>80-130</td>
<td>&lt; 180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-2 hrs after meal</td>
<td></td>
</tr>
<tr>
<td>AACE</td>
<td>&lt; 6.5%</td>
<td>&lt; 110</td>
<td>&lt; 140</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 hrs after meal</td>
<td></td>
</tr>
<tr>
<td>IDF</td>
<td>&lt; 7%</td>
<td>&lt; 115</td>
<td>&lt; 160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-2 hrs after meal</td>
<td></td>
</tr>
</tbody>
</table>

Target Glucose Levels in the Hospital

Non-Insulin Therapies in the Hospital

• Sulfonylureas major cause of hypoglycemia
• Metformin CI in setting of decreased or acutely changing renal function, iodinated contrast dye, hypoxia
• TZDs associated with edema and HF
• GLP-directed therapies can cause nausea and have a greater effect on post-prandial glucose
• Many take days or weeks to see glycemic effects

Inpatient Hyperglycemia Treatment

Antihyperglycemic Therapy

- IV Insulin
- SC Insulin

Sliding-Scale Insulin Regimen

Sliding-scale insulin (SSI) is widely used
- Subcutaneous regular human insulin, given as sole modality of insulin Rx, when hyperglycemia occurs
- Insulin dose based on BG measurements taken 4 times per day before meals and at bedtime
- Insulin is often not given until BG is >200 mg/mL

Limitations
- Reactive instead of proactive
- Does not provide basal insulin
- Glycemic control is rarely assessed
- Previous regimen (oral agent &/or insulin) is not accounted for when calculating SSI dosage
- Has been shown in clinical trials to be ineffective

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**Physiologic Insulin Secretion**

Normal 24-Hour Profile

![Graph showing normal 24-hour insulin secretion profile]

**SC Insulin in the Hospital: Practical Guidelines for non-ICU patients**

<table>
<thead>
<tr>
<th>Rx</th>
<th>Scheduled</th>
<th>Nutritional</th>
<th>Correctional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td>Nutritional</td>
<td>Correctional</td>
<td></td>
</tr>
<tr>
<td>• Long-acting insulin analog</td>
<td>• Rapid-acting insulin analog</td>
<td>• Rapid-acting or Regular when fingerstick BG above target</td>
<td></td>
</tr>
<tr>
<td>• NPH</td>
<td>• Regular</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Fingerstick BG monitoring: before meals and at bedtime if eating; every 4-6 hours if not eating;
- Rapid insulin given with nutrition; regular 30 mins pre-nutrition


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**RABBIT-2 Trial: Randomized Basal-Bolus versus Sliding Scale Regular Insulin in patients with T2DM**

- D/C oral antidiabetic drugs on admission
- Starting TDD:
  - 0.4 units/kg/day if BG 140-200 mg/dL
  - 0.5 units/kg/day if BG > 200 mg/dL
- 50% of TDD as long-acting (insulin glargine) and 50% as rapid-acting (glulisine)
  - Glargine – once daily at same time/day
  - Glulisine – three equally divided doses with meals


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**Correctional Scale**

- Before meal: Added to scheduled bolus dose
- Bedtime: given ⅓ of scale dose

<table>
<thead>
<tr>
<th>Blood Glucose (mg/dL)</th>
<th>Insulin Sensitive</th>
<th>Usual</th>
<th>Insulin Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>141-180</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>181-220</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>221-260</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>261-300</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>301-350</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>351-400</td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>&gt;400</td>
<td>14</td>
<td>16</td>
<td>18</td>
</tr>
</tbody>
</table>


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**RABBIT-2 Trial: Results**

![Graph showing results of RABBIT-2 trial]

Hypoglycemia occurred in < 1% of readings with no significant difference between groups.


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**RABBIT-2 Surgery Study: Results**

<table>
<thead>
<tr>
<th>Outcomes and Hypoglycemia</th>
<th>SSI</th>
<th>Basal-Bolus (glargine + glulisine)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Complications* (%)</td>
<td>24.3</td>
<td>8.6</td>
<td>0.003</td>
</tr>
<tr>
<td>Postsurgery ICU admission (%)</td>
<td>21</td>
<td>13</td>
<td>NS</td>
</tr>
<tr>
<td>ICU Length of Stay (days)</td>
<td>3.19±2.14</td>
<td>1.23±0.60</td>
<td>0.003</td>
</tr>
<tr>
<td>BG&lt;70 mg/dL</td>
<td>4.7</td>
<td>23.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BG &lt; 40 mg/dL</td>
<td>0</td>
<td>3.8</td>
<td>0.057</td>
</tr>
</tbody>
</table>

* Composite of postoperative complications including wound infection, pneumonia, bacteremia, and respiratory and acute renal failure.

Estimating Total Daily Dose (TDD)
- If on insulin at home, consider home dose and glycemic control
- If not on insulin at home, consider BMI, initial BG, hypo- or hyperglycemic risk factors
- TDD = 0.3-0.6 units/kg/day (many protocols use 0.4-0.5)
- TDD split 50% basal and 50% bolus

<table>
<thead>
<tr>
<th>Lower End</th>
<th>Higher End</th>
</tr>
</thead>
<tbody>
<tr>
<td>insulin sensitive</td>
<td>insulin resistant</td>
</tr>
<tr>
<td>ESRD</td>
<td>obese</td>
</tr>
<tr>
<td>lean (BMI&lt;25)</td>
<td>high dose or increasing dose of steroids</td>
</tr>
<tr>
<td>recent hypoglycemia</td>
<td>very high glucose values</td>
</tr>
<tr>
<td>decreasing dose of steroids</td>
<td>older age</td>
</tr>
</tbody>
</table>

Starting Basal-Bolus Insulin
LT weighs 198 lbs (90 kg)
Daily insulin requirement = 0.4 units/kg/day
TDD = 36 units/day

Basal-Bolus Daily Dose Adjustments
- Avoid clinical inertia
- Based on glucose values, insulin doses day before, other factors (health status changes, infection, steroid dose)

<table>
<thead>
<tr>
<th>Blood Glucose Levels</th>
<th>Change in Daily Insulin Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-meal BG 100-140 mg/dL; no hypoglycemia</td>
<td>No change</td>
</tr>
<tr>
<td>Pre-meal BG 141-180 mg/dL; no hypoglycemia</td>
<td>Increase by 10%</td>
</tr>
<tr>
<td>Pre-meal BG &gt; 180 mg/dL; no hypoglycemia</td>
<td>Increase by 20%</td>
</tr>
<tr>
<td>Pre-meal BG 70-99 mg/dL; no hypoglycemia</td>
<td>Decrease by 10%</td>
</tr>
<tr>
<td>Pre-meal BG &lt; 70 mg/dL</td>
<td>Decrease by 20%</td>
</tr>
</tbody>
</table>

Basal Plus Trial
- D/C oral antidiabetic drugs on admission
- Basal-Bolus
  - Glargine once daily + glulisine before meals + glulisine correction doses
  - TDD = 0.5 units/kg/day (50% glargine, 50% glulisine)
- Basal-Plus
  - Glargine once daily + glulisine correction doses
  - TDD = 0.25 units/kg/day (glargine)
- Sliding scale regular insulin

Basal Plus Trial: Results

<table>
<thead>
<tr>
<th></th>
<th>Basal-Bolus*</th>
<th>Basal Plus*</th>
<th>SSI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG after first day of therapy</td>
<td>156 ± 36</td>
<td>163 ± 37</td>
<td>172 ± 41</td>
<td>0.046</td>
</tr>
<tr>
<td>Treatment failures (%)</td>
<td>0</td>
<td>2</td>
<td>19</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BG &lt; 70 mg/dL (%)</td>
<td>1.7</td>
<td>1.1</td>
<td>0.4</td>
<td>0.019</td>
</tr>
<tr>
<td>BG &lt; 40 mg/dL (%)</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Case 1 – Part 2
- On hospital day #4, LT’s pneumonia symptoms have improved significantly. He is afebrile and has been switched to oral antibiotics.
- LT was initiated on basal-bolus SC insulin therapy; his doses were adjusted daily per the hospital protocol

<table>
<thead>
<tr>
<th></th>
<th>Hospital Day #1</th>
<th>Hospital Day #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal: Insulin glargine</td>
<td>18 units once daily</td>
<td>24 units once daily</td>
</tr>
<tr>
<td>Nutritional:</td>
<td>6 units with each meal</td>
<td>8 units with each meal</td>
</tr>
<tr>
<td>Insulin aspart</td>
<td>Usual</td>
<td>Usual</td>
</tr>
<tr>
<td>Correctional Scale</td>
<td>Usual</td>
<td>Usual</td>
</tr>
</tbody>
</table>
Case 1 – Part 2

<table>
<thead>
<tr>
<th></th>
<th>AM</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>228</td>
<td>320</td>
<td>239</td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td>108</td>
<td>357</td>
<td>97</td>
<td>160</td>
</tr>
<tr>
<td>Wednesday</td>
<td>132</td>
<td>164</td>
<td>102</td>
<td>189</td>
</tr>
<tr>
<td>Thursday</td>
<td>75</td>
<td>139</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What discharge diabetes medication regimen would you recommend?

A. Stop insulin and restart metformin and liraglutide
B. Continue basal insulin and re-initiate metformin and liraglutide
C. Continue basal and bolus insulin and re-initiate metformin and liraglutide
D. Continue basal and bolus insulin and discontinue metformin and liraglutide

What other instructions should LT receive prior to discharge?

A. How to titrate basal insulin dose
B. How to prevent and treat hypoglycemia
C. How to count carbohydrates for insulin dosing
D. A and B
E. A, B, and C

Successful transition out of the hospital

1) Discharge glycemic control regimen tailored to the educational, financial, and motivational profile of the patient
2) Adequate education (including learner assessment)
3) Appropriate follow-up
4) Referral to community resources
5) Minimization of chance of hypoglycemia and possibility of error

Optimal Discharge Regimen:

**Important Considerations**

- A1C on admit
- Home medications
- Current medical problems
- Nutritional status
- Renal function
- New contraindications to oral medications
- Hypoglycemia risk factors
- Goals of care and life expectancy
- Resources
- Patient motivation and self-management abilities
- Family member and/or caregiver support
- Outpatient follow-up

Discharge Planning Depends on Etiology of Hyperglycemia

- **Previously Diagnosed Diabetes**
  - Assessment
  - Adjust therapy as needed
  - Assess for complications
  - Outpatient follow-up

- **Previously Undiagnosed Diabetes**
  - Plan to confirm diagnosis, implement therapy and education

- **Temporary Hyperglycemia**
  - Requires in hospital testing

- **Inpatient Hyperglycemia**
  - Requires follow-up testing
Discharge Recommendations

Patients With Previously Diagnosed Diabetes

<table>
<thead>
<tr>
<th>HbA1c Indication</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0-7.5%</td>
<td>• Increase dose of home agents • Add on additional agent • Add basal insulin at bedtime</td>
</tr>
<tr>
<td>7.6-9.0%</td>
<td>• If already on 2 noninsulin agents, add a 3rd agent (consider once daily basal insulin at bedtime)</td>
</tr>
<tr>
<td>≥9%</td>
<td>• Discharge home on basal and bolus insulin regimen • May use amount of basal insulin required in hospital as once daily glargine/detemir or twice daily NPH dose • Twice daily premixed insulin may be considered for less complex insulin regimens, particularly in elderly patients • Alternate: continue home agents and add basal insulin</td>
</tr>
</tbody>
</table>

Discussion Questions:

What is required to successfully send a patient home on basal insulin?

What might be the barriers to starting basal insulin in this patient?

Discharging a Patient on Insulin

• Never been on insulin as an outpatient
  – Use the basal amount required in the hospital (50% of TDD)
  – Consider using 50-80% of basal dose used in hospital
  – If multiple risks for hypoglycemia, start at 10 units at bedtime and titrate
  – Consider dose titration
  – Develop call parameters for downward or upward trends
  – Schedule follow-up visit shortly after discharge
• On insulin as an outpatient
  – Consider changing insulin needs during hospitalization
  – Transitioning between basal insulin products

Possible Barriers to Glycemic Control with Insulin

• Clinical inertia
• Anxiety or fear of hypoglycemia
• Concerns about weight gain
• Fear or anticipated pain of injections
• Apprehensions about the demands of the treatment regimen
• Resistance due to inconvenience of lifestyle restrictions
• Resource issues (insurance coverage, supplies, correct Rx, SMBG and education)

Facilitating Patient Acceptance and Adherence of Insulin Therapy

• Educate patients from the beginning of the disease process
• Avoid threatening patients with insulin
• Use a simple insulin regimen to start
• Allow patients to participate in their insulin dose titration
• Ensure they have the tools and resources needed
• Discuss the goals and expectations
  – Patients who receive education about their glycemic goals are more likely to accept insulin therapy

Diabetes Education for the Hospitalized Patient

• Be Proactive; Start Early
• Challenges
  – Patient is ill
  – Under increased stress
  – Environment not conducive to learning
  – Unable to get enough rest
  – Distractions (TV, telephone, meal times, procedures)
  – Shock of diagnosis (denial, anger, grief)
  – Workload
**Patient Understanding of Meds at Discharge**

172 patients discharged from community-based teaching hospital with prescriptions for 1 or more new medications

<table>
<thead>
<tr>
<th>Understanding</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recalled being told of ANY possible adverse effect</td>
<td>15%</td>
</tr>
<tr>
<td>Could name ≥1 possible adverse effect</td>
<td>22%</td>
</tr>
<tr>
<td>Knew dose</td>
<td>56%</td>
</tr>
<tr>
<td>Knew medication purpose</td>
<td>64%</td>
</tr>
<tr>
<td>Knew medication name</td>
<td>64%</td>
</tr>
<tr>
<td>Knew dosing schedule</td>
<td>68%</td>
</tr>
<tr>
<td>Aware that new medications had been prescribed</td>
<td>100%</td>
</tr>
</tbody>
</table>


**“Survival Skills” Education**

- Patients newly diagnosed or new to insulin and/or SMBG
- Determined by medical necessity and patient’s desires and previous experiences
  - What is diabetes
  - SMBG and norms/targets for blood glucose
  - Hypoglycemia
  - Nutrition
  - Insulin administration
  - Sick-day management
  - Community resources


**CASE #2**

SK is a 38 year old Caucasian female

**HPI:** Admitted to hospital this morning with upper urinary tract infection

- Presented at urgent care with dysuria x 3 days, fever and fatigue x 2 days, and poor appetite x 24 hours
- BG = 291 mg/dL
- Administered regular insulin 10 units in emergency room prior to admission

**Past Medical History**

- History of diabetes x 6 years (started insulin pump 2 months ago)
- History of recurrent UTIs (4 in past 2 years)
- History 2 pregnancies – 1 live birth

**Medications**

**Home Medications:**
- Insulin aspart via insulin pump (started 2 months ago)
- Enalapril 10mg PO daily
- Norelgestromin/ethinyl estradiol patch Qweek
- Calcium carb 600mg + vitamin D 800 IU daily

**Hospital Medication Orders**
- Insulin – pump continued for now
- Enalapril 10mg PO daily
- Levofoxacin 500mg IV Q24 hours

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Case #2

Social & Family Hx:
• Resides with husband and 11 year old son
• Works as salesperson in department store
• Does not smoke tobacco or use illicit drugs
• Drinks 1-2 alcoholic beverages occasionally on weekends
• Father has T2DM
• Mother has RA

Case #2

Case #2

Vital Signs:
BP = 106/64
Weight = 134 lbs
BMI = 20.2
Pulse = 94, regular
Height = 5’ 7”

Labs (drawn in ED):
Glucose = 291 mg/dL
BUN = 24
Scr = 1.3
eGFR = 53 ml/min
Na = 121
K = 4.5
Cl = 103

AM (Fasting) Pre-Lunch Pre-Dinner Bedtime
Monday 88 167 96 123
Tuesday 67 131 73 134
Wednesday 64 96 68 153
Thursday 77 137 133 104
Friday 169 211 232 191
Saturday 263 288 357 230
Sunday 301

Which of the following would be the most appropriate next step in terms of managing SK’s diabetes?

A) Test for urine and serum ketones
B) Test for anti-GAD and islet cell antibodies
C) Discontinue her insulin pump and initiate a sliding scale insulin order
D) Discontinue her insulin pump and initiate a basal/bolus insulin regimen

Which of the following should be anticipated in terms of this patient’s insulin dosing requirements during the hospital stay?

A. Higher than home doses
B. Lower than home doses
C. About the same when compared to home doses
D. Difficult to predict – probably will be higher but may be lower than home doses

You are responsible for gathering the medication history and performing med reconciliation. Which of the following would be the most critical to document in SK’s chart?

A) Last known menstrual period
B) History of allergies to pork or eggs
C) Prior use of oral and injectable antihyperglycemic medications
D) Pre-hospital basal insulin infusion rate(s), bolus doses given in past 48 hours, and TDD.
Mini Review: DM Types

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>T1DM</th>
<th>T2DM</th>
<th>LADA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical age of onset</td>
<td>&lt;35</td>
<td>&gt;35</td>
<td>&gt;35</td>
</tr>
<tr>
<td>Onset</td>
<td>Rapid</td>
<td>Slow</td>
<td>Slow</td>
</tr>
<tr>
<td>Risk of DKA</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Family history of DM</td>
<td>Uncommon</td>
<td>Common</td>
<td>Uncommon</td>
</tr>
<tr>
<td>Personal/Family history of autoimmune disease</td>
<td>Common</td>
<td>Uncommon</td>
<td>Common</td>
</tr>
<tr>
<td>Body type</td>
<td>Fit / Lean</td>
<td>Overweight / Obese</td>
<td>Normal / Overweight</td>
</tr>
<tr>
<td>Components of metabolic syndrome</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>C-peptide level</td>
<td>Undetectable-Low</td>
<td>Normal-High</td>
<td>Low-Normal</td>
</tr>
<tr>
<td>Anti-GAD; Anti-ICA; Anti-IA2</td>
<td>Positive</td>
<td>Negative</td>
<td>Positive</td>
</tr>
</tbody>
</table>


CSII – The Basics

- Continuous subcutaneous infusion of rapid acting insulin (lispro, aspart, glulisine)
- Several manufacturers - slightly different technology/features
- Basal dose (units/hour)
  - Typically 0.2-0.5 units/kg/day or about 40-60% of TDD
  - Pump can be programmed to provide different doses throughout the day
- Bolus doses (delivered immediately or over 1-2 hours)
  - Typically based on anticipated carbohydrate intake AND blood glucose measurement
  - Insulin:carb ratio typically 1 unit:12-15 grams for food intake
  - Sensitivity factor typically 1 unit:40-60 mg/dL for corrections
  - Bolus wizard can be used to help calculate appropriate dose and “insulin on board” feature can minimize risk of dose stacking

Available Insulin Pumps

Animas: OneTouch Ping
Medtronic-MiniMed: Paradigm
Insulet Corp: Omni Pod
Roche: Accu-Check Spirit

CSII – The Good and Bad

**Advantages**
- Improve glycemic control
- Precise dose delivery
- ↓ incidence of extreme hypo- and hyperglycemia
- Improve flexibility in lifestyle (meals, exercise, travel, sleeping in late)

**Disadvantages**
- Requires meticulous self-monitoring
- Site infections
- Pump malfunction (rare)
- Bodily attachment
- Expensive

Insulin Pump Use in Hospitalized Patients

- Patients admitted to hospital often have more knowledge and experience with insulin pump therapy than medical professionals
- ADA Standards – Patients who use an insulin pump in outpatient settings are candidates for self-management in hospital if:
  - The patient has the mental and physical capacity
  - The hospital has a CSII policy that permits self-management
  - The hospital has personnel with expertise on pump management

Insulin Pump Use in Hospital

- **Patient Assessment**
  - Glycemic control (prior to hospitalization)
  - Ability to perform bolus calculation
  - Ability to deliver a bolus dose
  - Ability to change the basal rate and suspend insulin delivery
  - Hypoglycemic unawareness
- **Documentation**
  - Pump manufacturer and model #
  - Insulin used in pump (e.g. lispro, aspart, glulisine)
  - Insulin doses and pump settings

Contraindications to Pump Use in Hospital

- Altered state of consciousness
- Diabetic ketoacidosis
- Insulin-pump malfunction
- Lack of supplies for the insulin pump
- Patient unwilling to participate
- Suicidal ideation

Documentation for CSII Use

- Signed Patient Agreement
  - Stipulates conditions for continued use and when it may be discontinued
  - States that patient is responsible for pump supplied
  - Terms of use and release of liability for using patient-owned pump
- Patient-Maintained Flow Sheet at Bedside
  - BG readings
  - Insulin dose (basal rate and bolus doses)
  - Carbohydrate intake (grams)

Insulin Pumps - Basic Info / Settings

- Basal insulin delivery
  - Current basal insulin delivery rate
  - Scheduled basal insulin delivery rates (over 24 hours)
  - Basal review (how much was provided in recent past)
  - Temporary basal rate change or hold
- Bolus insulin delivery
  - Current insulin:carb ratio
  - Current sensitivity factor
  - Current glucose target
  - Review basal dosing history
  - Change insulin:carb ratio, sensitivity factor, and glucose target

Insulin Dosing Requirements in Hospital

- Dosing requirements are hard to predict
  - Physiological stress often increases insulin requirements but not always
  - Food intake is often different (i.e. periods of anorexia/fasting, carb intake, total calories)
  - Medical conditions such as hypotension, edema, acute renal failure, surgery can impact insulin requirements
  - Home regimen may not have been adequate

CSII – Inpatient Experience

- Few studies have been published regarding risks and benefits of continuing insulin pump therapy in hospital
- One retrospective study found that "pump on" patients were less likely to experience hypoglycemia (BG < 70mg/dL) during their hospital stay when compared to "pump off" patients (35% vs. 84%, p<0.001).
Day 2. KS had a CT scan at 10am. Her BG was 123 mg/dL prior breakfast (7am). After the scan her BG was 197 mg/dL prior to lunch (12:30pm) and is now 296 mg/dL (3pm). Which of the following would be the most appropriate action to take?

A) Inspect the pump, tubing, and insertion site
B) Increase her insulin:carb ratio and sensitivity factor by 20%
C) Instruct the nursing staff to check her blood glucose more frequently
D) Discontinue pump therapy and initiate insulin glargine 20 units QHS and insulin aspart 10-15 units prior to meals

Corrective action is taken and her next BG is 163mg/dL. Thirty minutes later the patient’s family rings the nurse’s call button. The patient is incoherent and her BG monitor is sitting in her lap (BG = 51mg/dL). Which of the following would be the most appropriate action now?

A) Call a code blue
B) Reduce basal insulin dose by 20%
C) Give patient 1 amp (50ml) of D50 IV
D) Give patient a 15 gm tube of glucose PO

Troubleshooting

- Troubleshooting should be prompted by
  - An alarm
  - An unusually (unexpectedly) high BG reading
- What to check and consider changing
  - Bolus doses given and basal rate
  - Insulin and reservoir cartridge
  - Insertion site and tubing

ADA Recommendations - Hypoglycemia

- Oral glucose (15-20g) is the preferred treatment for a conscious individual
- Once a patient recovers from an episode, the individual should consume a meal or snack to avoid a recurrence
- Glucagon should be prescribed for all people at significant risk of severe hypoglycemia
- Those with hypoglycemia unawareness or episodes of severe hypoglycemia should raise glycemic targets for at least several weeks to strictly avoid further hypoglycemia and partially reverse hypoglycemia unawareness

Case 2 – Part 2

On day 4 the patient is afebrile and ready to go home. A prescription is given for oral antibiotics. The patient’s pre-hospital insulin regimen was:

- **Basal rate:** 0.4 units/hour from 9am to 1am and 0.5 units/hour 1am to 9am
- **Bolus doses:**
  - Insulin:carb ratio 1 unit : 18 gram
  - Sensitivity factor 1 unit per 40 mg/dL
  - Target Blood Glucose = 110 mg/dL
Case # 2 – Part 2

<table>
<thead>
<tr>
<th></th>
<th>AM</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
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<tbody>
<tr>
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<td>88</td>
<td>167</td>
<td>96</td>
<td>123</td>
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<td>Tuesday</td>
<td>67</td>
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<td>Friday</td>
<td>169</td>
<td>211</td>
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<tr>
<td>Saturday</td>
<td>263</td>
<td>288</td>
<td>357</td>
<td>230</td>
</tr>
<tr>
<td>Sunday</td>
<td>301/356</td>
<td>261/197</td>
<td>204/168</td>
<td>198</td>
</tr>
<tr>
<td>Monday</td>
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<td>197/296/163</td>
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<td>Tuesday</td>
<td>95/103</td>
<td>121/137</td>
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</tr>
<tr>
<td>Wednesday</td>
<td>87</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Which of the following would be the most appropriate medication regimen to control hyperglycemia in the case of SK after hospital discharge?

A) Add canagliflozin and continue pre-hospital basal rate and bolus dose parameters
B) Decrease pre-hospital basal rate by 10% and keep bolus dose parameters unchanged
C) Increase pre-hospital basal rate by 10% and keep bolus dose parameters unchanged
D) Discontinue insulin pump and switch to insulin glargine plus insulin aspart prior to meals

Which of the following would be the most important to include in the discharge plan for KS?

A) Appointment with dietician to review dietary habits and accuracy of carb counting
B) Prescription for nitrofurantion 50mg PO daily to prevent future urinary tract infections
C) Scheduled follow-up call to review home glucose monitoring readings 3-4 days after hospital discharge
D) Write new prescriptions for enalapril and Ortho-Evra patch to be filled when current supplies are exhausted.

Transition to Home

- If patient had reasonably good glycemic control prior to hospital admission, resume pre-hospital insulin regimen
- If major changes are made in the insulin regimen, they should ideally be made one day in advance of hospital discharge to determine patient’s response
- Written and oral instructions should be given to the patient (and the family) prior to discharge
- Scheduled follow-up (either by phone or face-to-face) should occur within a few days of hospital discharge

Insulin Add On Therapy DM Type 1

- Amylin (pramlintide)
  - Approved for combo with insulin in patients with DM1 and DM2
  - Improves post-prandial BG by several mechanisms
  - Can’t be mixed with insulin
- GLP-1 agonists (exenatide, liotaglutide)
  - Approved for monotherapy and combo with oral agents for DM2
  - Some data in combination with insulin and in DM1
  - Perhaps useful to preserve β-cells? Reduce risk of hypoglycemia?
- SGLT2 inhibitors (canagliflozin, empagliflozin, dapagliflozin)
  - Approved for monotherapy and combo with oral agents for DM2
  - Unique MOA – causes glucosuria
  - Theoretically useful in DM1; but DKA in DM2 reported (?mechanism?)

Key Points In Hospital Insulin Needs

- Hyperglycemia is common among hospitalized patients
- Most oral antidiabetic agents should be discontinued in hospital
- Sliding scale insulin regimens do not adequately control BG and may increase hypoglycemia risk
- Basal-bolus and basal-plus insulin regimens adjusted daily are evidence-based approaches
- Patient who use insulin pumps prior to hospitalization can continue to use them if they have the mental and physical capacity to do so
Key Points Transition to Home
• Patient’s need for diabetes education should be assessed (preferably at admission)
• Patients should receive necessary basic skills training
• Provide patient with post-discharge plan for diabetes
• Patient has received clear instructions about medications: Name, dosage, and when to take them
• Patient has a scheduled follow-up appointment at time of discharge
• Written documentation for primary care provider is completed (and transmitted) at time of discharge

Which of the following statements most accurately describes the clinical evidence related to intensive glycemic control in the hospital setting?
A) Most studies have shown that tight glycemic control reduces mortality without increasing rates of hypoglycemia
B) Most studies have shown that tight glycemic control reduces mortality but increases rates of hypoglycemia
C) Most studies have been conducted in the general medicine (non-ICU) patient population
D) Studies have been unable to reproduce the positive results seen in the initial landmark study.

According to the AACE/ADA as well as the Endocrine Society guidelines, which of the following is the recommended fasting blood glucose goal for most hospitalized patients in a non-ICU setting?
A. 70-110 mg/dL
B. <120mg/dL
C. <140mg/dL
D. 140-180mg/dL

Ms. Jones has stated that she does not want to start insulin. Her A1c is 9.3%. Which of the following strategies is most likely to increase her acceptance of basal insulin therapy and persistence with treatment?
A. Clearly state to Ms. Jones the potential harms of refusing to take insulin therapy.
B. Explain to Ms. Jones that modern needles are very small and practically painless.
C. Allow Ms. Jones to self-titrate the insulin dose to a specific fasting glucose target range.
D. Enlist a family member to reinforce (daily) the importance of taking insulin to prevent future complications.

Which of the following insulin management strategies has been shown to reduce the risk of both hyperglycemia and hypoglycemia in hospitalized patients in non-ICU settings?
A. Continue metformin therapy in combination with insulin therapy throughout the hospital stay.
B. Provide bolus doses of insulin based on a sliding scale when the BG measurement is > 140mg/dL.
C. Provide a daily basal dose of long-acting insulin (0.25 units/kg) and correction doses based on a sliding scale.
D. Use an insulin infusion – either intravenous or subcutaneous – and adjust the infusion rate every 2-4 hrs.
A patient wearing an insulin pump in hospital has a BG reading of 123 mg/dL prior breakfast (7am), 197 mg/dL prior to lunch (12:30pm), and 296 mg/dL (3pm) despite a larger than usual bolus dose with lunch. Which of the following would be the most appropriate action to take?

A) Inspect the pump, tubing, and insertion site
B) Increase her insulin:carb ratio and sensitivity factor by 20%
C) Instruct the nursing staff to check her blood glucose more frequently
D) Discontinue pump therapy and initiate insulin glargine 20 units QHS and insulin aspart 10-15 units prior to meals