MANAGEMENT OF HYPERGLYCEMIA IN THE NONCRITICAL CARE SETTING
RECOGNITION AND DIAGNOSIS OF HYPERGLYCEMIA IN NONCRITICALLY ILL PATIENTS
RECOGNITION AND DIAGNOSIS OF HYPERGLYCEMIA AND DIABETES IN THE HOSPITAL SETTING

• **All patients**
  – Assess for history of diabetes
  – Test BG (using laboratory method) on admission independent of prior diagnosis of diabetes

• **Patients without a history of diabetes**
  – BG >140 mg/dL: Monitor with POC testing for 24-48 h
  – BG >140 mg/dL: Ongoing POC testing
  – Patients receiving therapies associated with hyperglycemia (eg, corticosteroids): monitor with POC testing for 24-48 h
    • BG >140 mg/dL: continue POC testing for duration of hospital stay

• **Patients with known diabetes or with hyperglycemia**
  – Test A1C if no A1C value is available from past 2-3 months

BG, blood glucose; POC, point of care.


RECOGNITION AND DIAGNOSIS
OF HYPERGLYCEMIA AND DIABETES
IN THE HOSPITAL SETTING

Upon admission
- Assess all patients for a history of diabetes
- Obtain laboratory blood glucose testing

No history of diabetes
BG >140 mg/dL
- Start POC
- CBG monitoring x 24-48 h
- Check A1C
  A1C ≥6.5%

History of diabetes
- CBG monitoring
A1C FOR DIAGNOSIS OF DIABETES IN THE HOSPITAL

• Implementation of A1C testing can be useful
  – Assist with differentiation of newly diagnosed diabetes from stress hyperglycemia
  – Assess glycemic control prior to admission
  – Facilitate design of an optimal regimen at the time of discharge

• A1C $\geq 6.5\%$ indicates diabetes
GLYCEMIC GOALS FOR NONCRITICALLY ILL PATIENTS
## INPATIENT GLYCEMIC MANAGEMENT: DEFINITION OF TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Hospital hyperglycemia</td>
<td>Any BG &gt;140 mg/dL</td>
</tr>
<tr>
<td>Stress hyperglycemia</td>
<td>Elevations in blood glucose levels that occur in patients with no prior history of diabetes and A1C levels that are not significantly elevated (&lt;6.5%)</td>
</tr>
<tr>
<td>A1C value &gt;6.5%</td>
<td>Suggestive of prior history of diabetes</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>Any BG &lt;70 mg/dL</td>
</tr>
<tr>
<td>Severe hypoglycemia</td>
<td>Any BG &lt;40 mg/dL</td>
</tr>
</tbody>
</table>
GLYCEMIC TARGETS IN NONCRITICAL CARE SETTING

- Maintain fasting and preprandial BG <140 mg/dL
- Modify therapy when BG <100 mg/dL to avoid risk of hypoglycemia
- Maintain random BG <180 mg/dL
- More stringent targets may be appropriate in stable patients with previous tight glycemic control
- Less stringent targets may be appropriate in terminally ill patients or in patients with severe comorbidities
Glucose Monitoring

ACHIEVING GLYCEMIC GOALS IN THE NONCRITICALLY ILL WHILE MINIMIZING HYPOGLYCEMIA RISK
MONITORING GLYCEMIA IN THE NONCRITICAL CARE SETTING

• **POC testing**
  – Preferred method for guiding ongoing glycemic management of individual patients
  – Timing of glucose measures should match patient’s nutritional intake and medication regimen

• **Recommended schedules for POC testing**
  – Before meals and at bedtime in patients who are eating
  – Every 4-6 h in patients who are NPO or receiving continuous enteral or parenteral nutrition

BG, blood glucose; POC, point of care.
Hospital Diet

ACHIEVING GLYCEMIC GOALS IN THE NONCRITICALLY ILL WHILE MINIMIZING HYPOGLYCEMIA RISK
MNT is an essential component of the glycemic management program for all hospitalized patients with diabetes and hyperglycemia.

Providing meals with a consistent amount of carbohydrate can be useful in coordinating doses of rapid-acting insulin to carbohydrate ingestion.

The hospital Carbohydrate Controlled diet provides an average of 60 grams of carbohydrate per meal and 30 grams of carb for bedtime snack.
Capillary blood glucose (mg/dL)

CBG values <70 mg/dL were less frequent in patients receiving the consistent carbohydrate diet (0.4 vs 3.2%, \( P=0.06 \))

Pharmacologic Therapy

ACHIEVING GLYCEMIC GOALS IN THE NONCRITICALLY ILL WHILE MINIMIZING HYPOGLYCEMIA RISK
Antihyperglycemic Therapy

SC Insulin
Recommended for most medical-surgical patients

Oral Antidiabetics
Not generally recommended

Continuous IV Infusion
Selected ICU patients

PHARMACOLOGICAL TREATMENT OF HYPERGLYCEMIA IN NON-ICU SETTING


GLYCEMIC MANAGEMENT STRATEGIES IN NONCRITICALLY ILL PATIENTS

- **Insulin therapy is preferred regardless of type of diabetes**
  - Discontinue noninsulin agents at hospital admission on most patients with type 2 diabetes with acute illness

- **Use scheduled SC insulin with basal, nutritional, and correction components**
  - Modify insulin dose in patients treated with Basal insulin before admission to reduce risk for hypoglycemia and hyperglycemia

“Sliding Scale” insulin alone is not recommended
INPATIENT MANAGEMENT OF HYPERGLYCEMIA: MANAGING SAFETY CONCERNS

• Both undertreatment and overtreatment of hyperglycemia create safety concerns

• **Areas of risk**
  – Changes in carbohydrate or food intake
  – Changes in clinical status or medications
  – Failure to adjust therapy based on BG patterns
  – Prolonged use of SSI as monotherapy
  – Poor coordination of BG testing with insulin administration and meal delivery
  – Poor communication during patient transfers
  – Errors in order writing and transcription
NONINSULIN THERAPIES IN THE HOSPITAL

- Time-action profiles of oral agents can result in delayed achievement of target glucose ranges in hospitalized patients
- **Sulfonylureas** are a major cause of prolonged hypoglycemia
- **Metformin** is contraindicated in patients with decreased renal function, use of iodinated contrast dye, and any state associated with poor tissue perfusion (CHF, sepsis)
- **Thiazolidinediones** are associated with edema and CHF
- α-Glucosidase inhibitors are weak glucose-lowering agents
- **Pramlintide and GLP-1 receptor agonists** can cause nausea and exert a greater effect on postprandial glucose

**Insulin therapy is the preferred approach**
**SUBCUTANEOUS INSULIN OPTIONS**

| **Basal insulin** | Controls blood glucose in the fasting state  
  • Detemir (Levemir), glargine (Lantus), NPH |
| **Nutritional (prandial) insulin** | Blunts the rise in blood glucose following nutritional intake (meals, IV dextrose, enteral/parenteral nutrition)  
  • Rapid-acting: lispro (Humalog), aspart (NovoLog), glulisine (Apidra), |
| **Correction insulin (sliding scale)** | Corrects hyperglycemia due to mismatch of nutritional intake and/or illness-related factors and scheduled insulin administration |
# PHARMACOKINETICS OF INSULIN PREPARATIONS

<table>
<thead>
<tr>
<th>Insulin</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nutritional</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid-acting analog</td>
<td>5-15 min</td>
<td>1-2 hours</td>
<td>4-6 hours</td>
</tr>
<tr>
<td>(aspart, glulisine, lispro)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>30-60 min</td>
<td>2-3 hours</td>
<td>6-10 hours</td>
</tr>
<tr>
<td><strong>Basal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detemir</td>
<td>2 hours</td>
<td>Relatively peakless</td>
<td>16-24 hours</td>
</tr>
<tr>
<td>Glargine</td>
<td>2-4 hours</td>
<td>Relatively peakless</td>
<td>20-24 hours</td>
</tr>
<tr>
<td>NPH</td>
<td>2-4 hours</td>
<td>4-10 hours</td>
<td>12-18 hours</td>
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**PHARMACOKINETICS OF INSULIN PRODUCTS**

The following is a 4 Step protocol that includes correction insulin (sliding scale), basal insulin and bolus (mealtime) insulin when indicated based on the patient’s CBG values.
INITIATING INSULIN THERAPY IN THE HOSPITAL – STEP 1 –
ON DAY ONE - DEFAULT ORDERS

1. Obtain accurate wt in kg
   - Initiate Hypoglycemic Protocol
   - Discontinue Oral Anti-diabetics
     - Nurse to contact MD to start basal insulin if CBG is > 140 mg/dL if not already on basal insulin
     - HbA1c upon admission
CAPILLARY BLOOD GLUCOSE MONITORING OPTIONS - STEP 1 – ON DAY ONE – CHOOSE ONE

• ACHS for patients that are eating

• Every 6 hours for Enteral or Parenteral nutrition

• Every 4 hours

• 2AM
CORRECTION SCALE (SLIDING SCALE) – STEP 2 – ON DAY ONE

• There are **four correction scale options**:

  ✓ **Sensitive:** pts < 70 kg, pts with renal failure, cirrhosis or frequent outpt hypoglycemia

  ✓ **Default:** use for most patients

  ✓ **Resistant:** consider for pts with CBG consistently > 300 mg/dL and those on high doses of steroids

  ✓ **Patients that are NPO > 24 hrs** or on **Enteral** or **Parenteral** feeds.
TYPE OF INSULIN TO USE FOR THE CORRECTION SCALE

- **Lispro (Humalog):** patients that are on PO diet or NPO patients expected to eat within 24 hours

- **Humulin R (Regular):** for enteral or Parenteral nutrition patients only
INSULIN THERAPY – STEP 3 – ON DAY ONE

• If patient already on outpatient Glargine (Lantus) or Detemir (Levemir), start Glargine at 0.25 units/kg/day

• Special consideration should be given to patients with renal failure, cirrhosis, frequent outpt hypoglycemia, and the elderly – start Glargine (Lantus) at 0.15 units/kg/day

INSULIN THERAPY - STEP 3 – ON DAY ONE

- If patient not on outpatient Glargine (Lantus), start Glargine as follows:
  - For CBG < 140 mg/dL, do not start Glargine, simply use correction scale.
  - For CBG 140-200 mg/dL, start Glargine at 0.2 units/kg/day
  - For CBG 201-400 mg/dL, start Glargine at 0.25 units/kg/day

Special consideration should be given to patients with renal failure, cirrhosis, frequent outpt hypoglycemia, and the elderly – start Glargine (Lantus) at 0.15 units/kg/day
INSULIN THERAPY - STEP 4 – ON DAY TWO (OR EARLIER IF 3 CONSECUTIVE CBG VALUES ARE > 200) FOR PATIENTS THAT ARE EATING

- For patients receiving Basal Insulin and Correction (sliding scale) insulin and the mean daily CBG > 200 mg/dL or three consecutive CBG are > 200 mg/dL, add bolus (mealtime) insulin.

- This is given with food in addition to correction Insulin
INSULIN THERAPY - STEP 4 – ON DAY TWO (OR EARLIER IF 3 CONSECUTIVE CBG VALUES ARE > 200 MG/DL) FOR PATIENTS THAT ARE EATING

• For CBG 201 – 400 mg/dL, start Lispro (Humalog) at 0.25 units/kg/day divided into 3 mealtime boluses.

• Special consideration should be given to patients with renal failure, cirrhosis, frequent outpt hypoglycemia, and the elderly – start Lispro (Humalog) at 0.15 units/kg/day divided into 3 mealtime boluses.
### RISK FACTORS FOR HYPOGLYCEMIA

<table>
<thead>
<tr>
<th>Variable</th>
<th>$P$ value</th>
<th>Univariate Analysis</th>
<th>Multivariate Analysis*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>GFR &lt;60 mL/s</td>
<td>0.005</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>TDD $\geq$0.5 U/kg</td>
<td>0.006</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Previous insulin use</td>
<td>&lt;0.001</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Insulin regimen (basal-bolus vs SSI)</td>
<td>&lt;0.001</td>
<td>0.001</td>
<td></td>
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</tbody>
</table>
STRATEGIES FOR REDUCING RISK FOR HYPOGLYCEMIA IN NONCRITICAL CARE SETTINGS

- Avoidance of sliding-scale insulin alone
- Use caution in prescribing oral antihyperglycemic agents
- Modify outpatient insulin doses in patients treated with insulin prior to admission
SPECIFIC CLINICAL SITUATIONS: PATIENTS WITH INSULIN PUMPS

• Patients who use CSII pump therapy in the outpatient setting can continue to use these devices as inpatients provided that they have the mental and physical capacity to do so.

• Availability of hospital personnel with expertise in CSII therapy is recommended.

A formal inpatient insulin pump protocol reduces confusion and treatment variability.
INPATIENT CSII PROTOCOL

• An insulin pump should NEVER be discontinued without initiation of either subcutaneous or intravenous insulin

• If the pump is discontinued for any reason, additional insulin (either IV or subcutaneous) MUST be given 30 minutes prior to discontinuation
HealthAlliance has an Insulin Pump Protocol

Patient gets screened for ability to manage insulin pump upon admission and each shift.

Patient must meet criteria per Insulin Pump Protocol to keep insulin pump during hospital stay.

MD role is to complete Inpatient Insulin Pump Physician orders and to consult provider managing pump in community or consult endo.
INPATIENT CSII THERAPY

Prevalence of hyperglycemia and hypoglycemia in inpatients who continued (pump on) or discontinued (pump off) CSII during their hospital stay


AACE Inpatient Glycemic Control Resource Center
SUMMARY

- Target BG: 100-180 mg/dL for most noncritically ill patients
- Insulin therapy preferred method of glycemic control in the hospital
  - Scheduled SC basal-bolus insulin therapy is effective and safe for treatment of hyperglycemia in noncritically ill patients
  - Sliding scale insulin alone is inappropriate once an insulin requirement is established