MANAGEMENT OF HYPERGLYCEMIA IN THE NONCRITICAL CARE SETTING

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RECOGNITION AND DIAGNOSIS OF HYPERGLYCEMIA IN NONCRITICALLY ILL PATIENTS

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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**
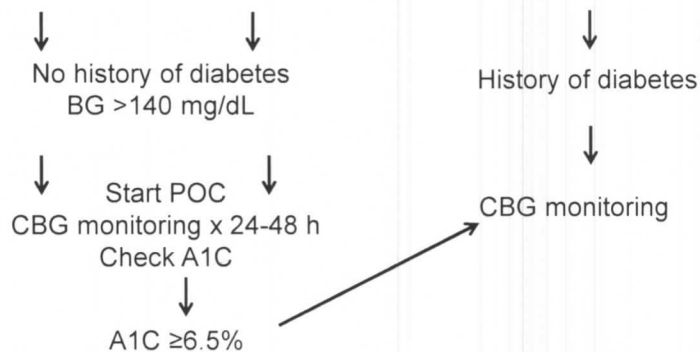 - Test A1C if no A1C value is available from past 2-3 months

BG, blood glucose; POC, point of care.
Moghissi ES, et al. *Endocrine Pract*. 2009;15:353-369.
Umpierrez GE, et al. *J Clin Endocrinol Metab*. 2012;97:16-38.

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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

History of diabetes

Start POC
CBG monitoring x 24-48 h
Check A1C

CBG monitoring

A1C ≥6.5%

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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

Moghissi ES, et al. *Endocrine Pract*. 2009;15:353-369.
Umpierrez GE, et al. *J Clin Endocrinol Metab*. 2012;97:16-38.

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GLYCEMIC GOALS FOR NONCRITICALLY ILL PATIENTS

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INPATIENT GLYCEMIC MANAGEMENT: DEFINITION OF TERMS

Hospital hyperglycemia	Any BG >140 mg/dL
Stress hyperglycemia	Elevations in blood glucose levels that occur in patients with no prior history of diabetes and A1C levels that are not significantly elevated (<6.5%)
A1C value >6.5%	Suggestive of prior history of diabetes
Hypoglycemia	Any BG <70 mg/dL
Severe hypoglycemia	Any BG <40 mg/dL

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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

Moghissi ES, et al. Endocrine Pract. 2009;15:353-369.
Umpierrez GE, et al. J Clin Endocrinol Metab. 2012;97:16-38.

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Glucose Monitoring

ACHIEVING GLYCEMIC GOALS IN THE NONCRITICALLY ILL WHILE MINIMIZING HYPOGLYCEMIA RISK

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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.
Moghissi ES, et al. *Endocrine Pract.* 2009;15:353-369.
Umpierrez GE, et al. *J Clin Endocrinol Metab.* 2012;97:16-38.

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Hospital Diet

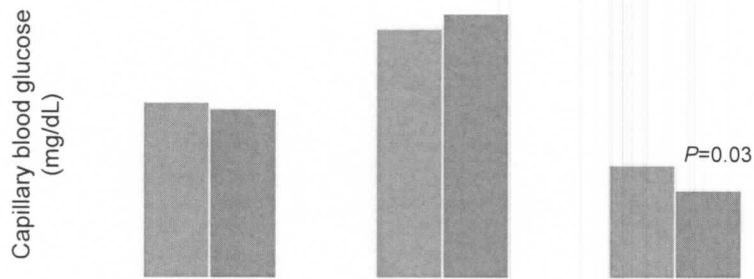# ACHIEVING GLYCEMIC GOALS IN THE NONCRITICALLY ILL WHILE MINIMIZING HYPOGLYCEMIA RISK

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MEDICAL NUTRITION THERAPY (MNT)

- 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.

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GLYCEMIC MEASURES IN PATIENTS ASSIGNED TO CONSISTENT CARBOHYDRATE OR LIBERAL DIETS IN THE HOSPITAL

P=0.03

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

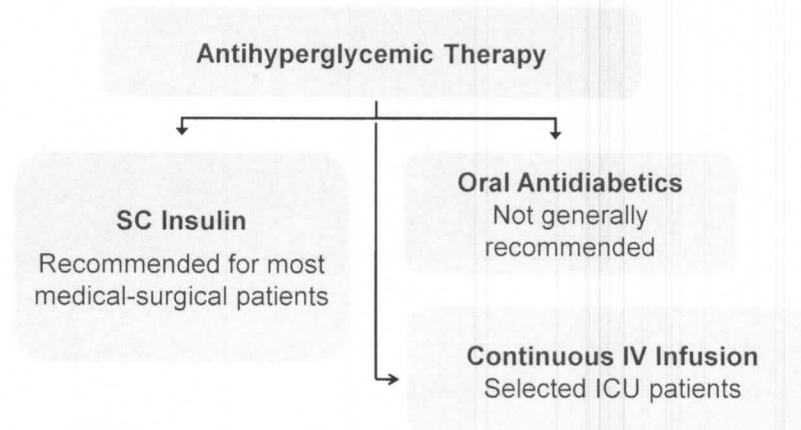Curll M, et al. *Qual Safety Health Care.* 2010;19:355-359.

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Pharmacologic Therapy

ACHIEVING GLYCEMIC GOALS IN THE NONCRITICALLY ILL WHILE MINIMIZING HYPOGLYCEMIA RISK

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PHARMACOLOGICAL TREATMENT OF HYPERGLYCEMIA IN NON-ICU SETTING

Antihyperglycemic Therapy

SC Insulin
Recommended for most medical-surgical patients

Oral Antidiabetics
Not generally recommended

Continuous IV Infusion
Selected ICU patients

Umpierrez GE, et al. *J Clin Endocrinol Metab.* 2012;97:16-38.
Smiley D, et al. *J Hosp Med.* 2010;5:212-217.

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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

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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

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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

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SUBCUTANEOUS INSULIN OPTIONS

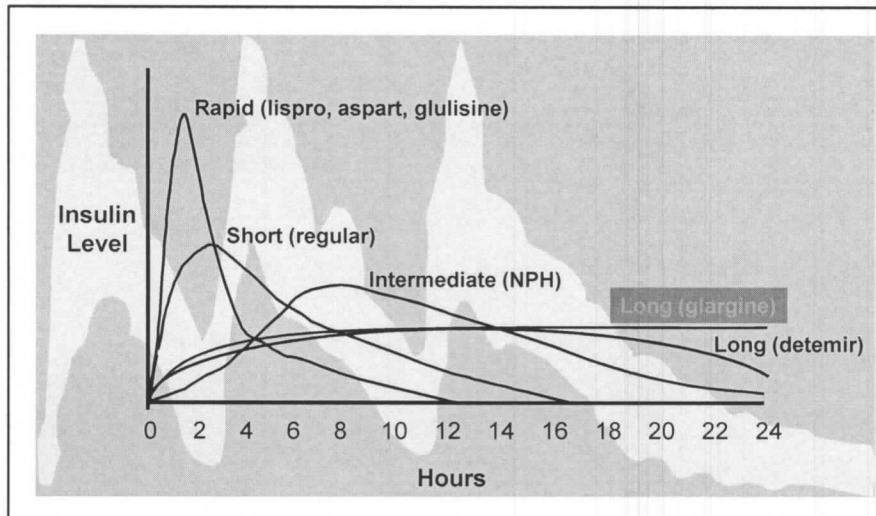| Basal insulin	Controls blood glucose in the fasting state •Detemir (Levemir), glargine (Lantus), NPH
Nutritional (prandial) insulin	Blunts the rise in blood glucose following nutritional intake (meals, IV dextrose, enteral/parenteral nutrition) •Rapid-acting: lispro (Humalog), aspart (NovoLog), glulisine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

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PHARMACOKINETICS OF INSULIN PREPARATIONS

Insulin	Onset	Peak	Duration
Nutritional			
Rapid-acting analog (aspart, glulisine, lispro)	5-15 min	1-2 hours	4-6 hours
Regular	30-60 min	2-3 hours	6-10 hours
Basal			
Detemir	2 hours	Relatively peakless	16-24 hours
Glargine	2-4 hours	Relatively peakless	20-24 hours
NPH	2-4 hours	4-10 hours	12-18 hours

Hirsch I. *N Engl J Med*. 2005;352:174-183.
Porcellati F, et al. *Diabetes Care*. 2007;30:2447-2552.

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PHARMACOKINETICS OF INSULIN PRODUCTS

Insulin Level

Rapid (lispro, aspart, glulisine)

Short (regular)

Intermediate (NPH)

Long (glargine)

Long (detemir)

0 2 4 6 8 10 12 14 16 18 20 22 24

Hours

Adapted from Hirsch I. *N Engl J Med.* 2005;352:174–183.

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HEALTHALLIANCE INPATIENT SUBCUTANEOUS INSULIN PROTOCOL

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.

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INITIATING INSULIN THERAPY IN THE HOSPITAL – STEP 1 –
ON DAY ONE - DEFAULT ORDERS

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

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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

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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.

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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

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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

Umpierrez GE, et al. *Diabetes Care*. 2007;30:2181-2186.

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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

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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

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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.

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RISK FACTORS FOR HYPOGLYCEMIA

Variable	P value	
	Univariate Analysis	Multivariate Analysis*
Age	<0.001	<0.001
GFR <60 mL/s	0.005	0.11
TDD ≥0.5 U/kg	0.006	0.31
Previous insulin use	<0.001	0.02
Insulin regimen (basal-bolus vs SSI)	<0.001	0.001

Farrokhi F, et al. ADA Scientific Sessions. 2011. Abstr. 2060-PO.
AACE Inpatient Glycemic Control Resource Center

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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

Braithwaite SS, et al. Endocr Pract. 2004;10(suppl 2):89-99.

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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

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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

Noschese ML, et al. *Endocr Pract*. 2009;15:415-424.

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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.

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INPATIENT CSII THERAPY
Prevalence of hyperglycemia and hypoglycemia in inpatients who continued (pump on) or discontinued (pump off) CSII during their hospital stay
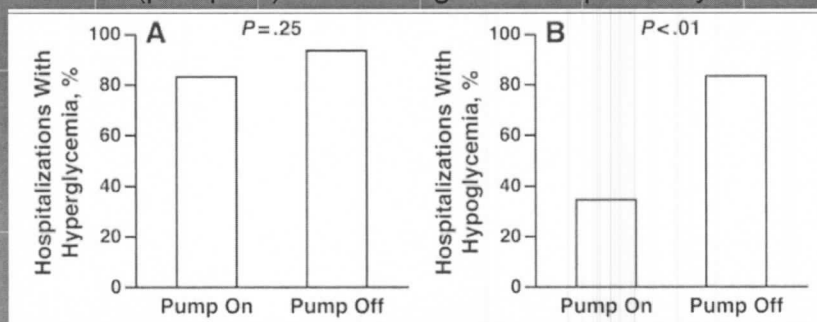
Bailon RM, et al. *Endocr Pract.* 2009;15:24-29.
AACE Inpatient Glycemic Control Resource Center

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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

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MANAGEMENT OF HYPERGLYCEMIA IN THE NONCRITICAL CARE SETTING

I acknowledge that I have read the training module (PowerPoint under "Reference Material" on the Management of Hyperglycemia in the Noncritical Care Setting.

Print Name:

Signature: _____ Date:

Please return this page with your application.