

# Hyperglycemic Crises

# First Principles in hyperglycemic syndromes

- What is causing hyperglycemia?
- How does DKA differ from HHS and other hyperglycemic syndromes;
  - Pathophysiology drives therapy
  - Choose the correct protocol

# Pathogenesis of Decompensated Diabetic States

- Infection/stress/dehydration → Absolute or relative insulin deficiency
  - ↑ Glucagon
  - ↑ Cortisol
  - ↑ Catecholamines
  - ↑ Growth hormone
- Starvation → ↑ lipolysis → FFA to liver
- → ↑ glucagon/insulin ratio → ketogenesis
- → ↑ gluconeogenesis and ↓ glucose utilization
- Hyperosmolar states more common in patients with relative insulin deficiency

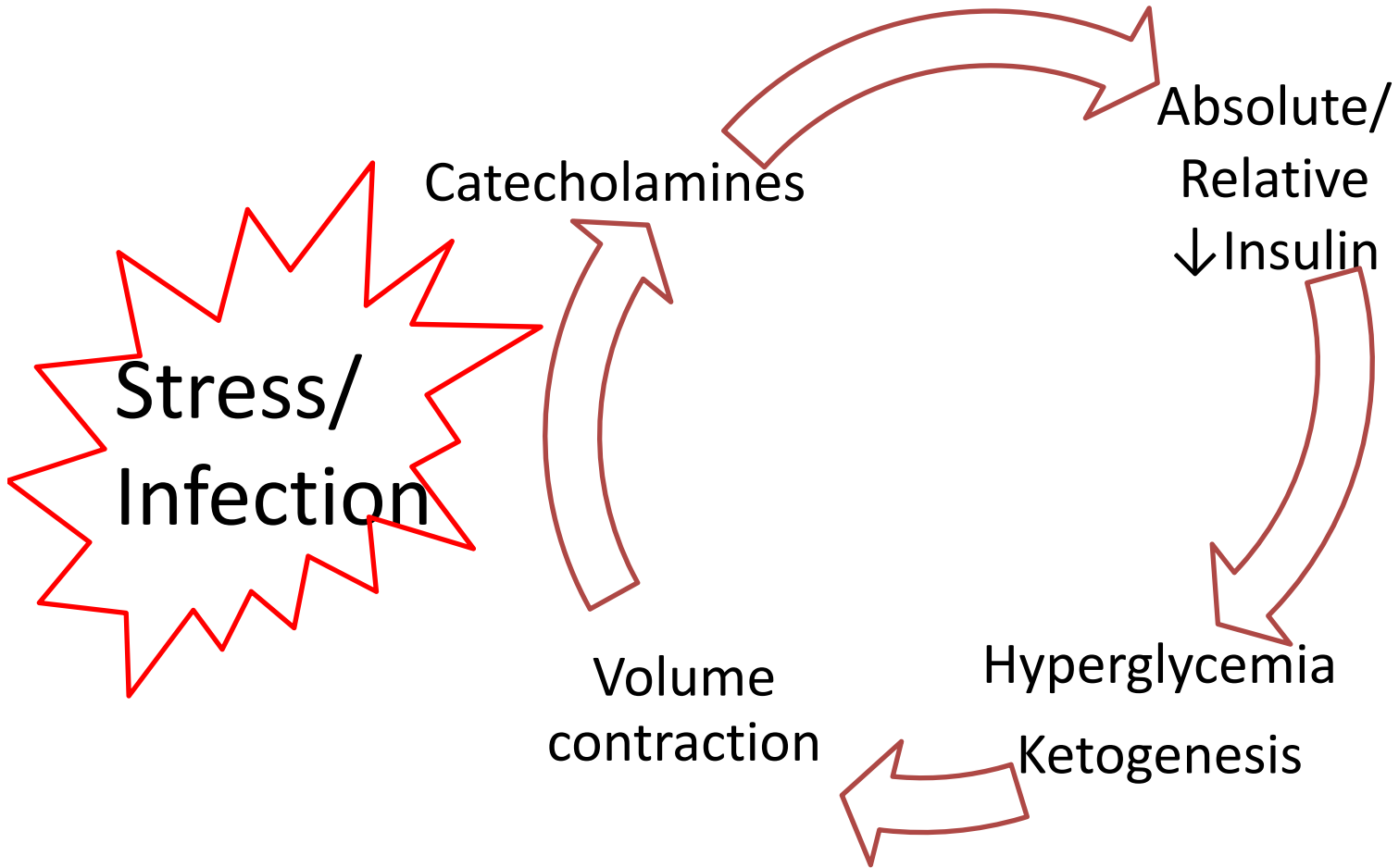
# Pathogenesis of DKA

- Adipose tissue;

↓Insulin / ↑Epinephrine  $\Rightarrow$  ↑ FFA

- Liver;

↓Insulin / ↑Glucagon  $\Rightarrow$  ↑ Ketones



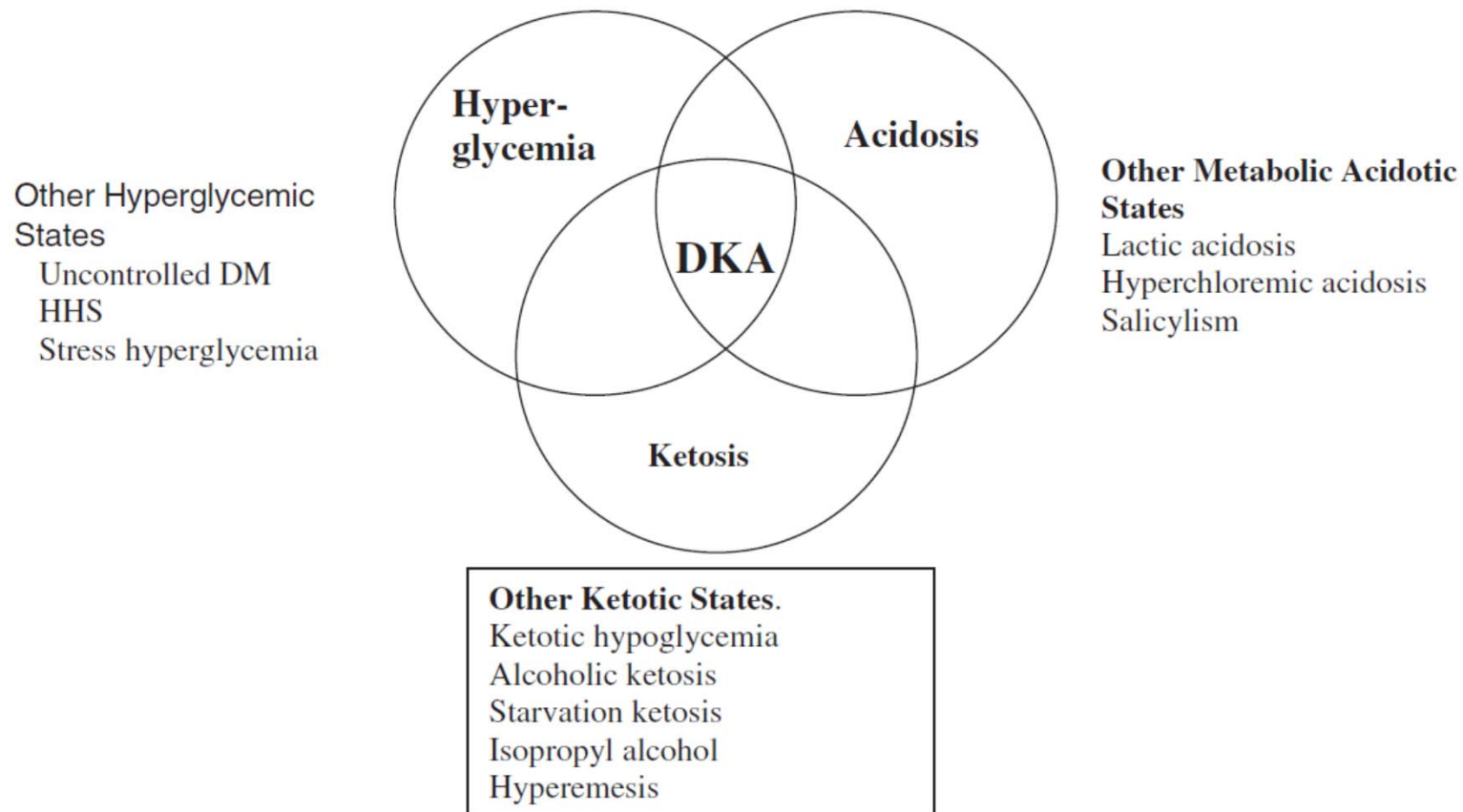
22 year old African-American woman presents with nausea, vomiting, weight loss, blurry vision. Multiple family members with diabetes. Ht 5'8", Wt 250 lbs. Acanthosis Nigricans on neck. Alert, abdominal pain+.

- ER Labs; Glucose 900 mg/dl
- $\beta$ -OHB; 4.5 mmol/L
- pH 7.20 pCO<sub>2</sub> 20, pO<sub>2</sub> 105
- Na<sup>+</sup> 125, K<sup>+</sup> 4.5, Cl 90, HCO<sub>3</sub><sup>-</sup> 12, Cr 1.5, BUN 40
- Ca<sup>++</sup> 9.0, Phos 5, Albumin 4
- WBC 15K, Hg 16, Lipase 600 (N < 140)
  
- Diagnosis: DKA vs HHS vs other

**Table 1**  
**Diagnostic criteria for DKA and HHS**

	Mild DKA	Moderate DKA	Severe DKA	HHS
Plasma glucose (mg/dL)	>250	>250	>250	>600
pH	7.25–7.3	7.0–7.24	<7.0	>7.3
Serum bicarbonate (mEq/L)	15–18	10–15	<10	>18
Ketones (urine or serum)	Positive	Positive	Positive	Minimal or negative
Anion gap	>10	>12	>12	Variable
Osmolality (mOsm/kg)	Variable	Variable	Variable	>320
Mental status	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

*Data from Kitabchi AE, Umpierrez GE, Miles JM, et al. Hyperglycemic crises in adult patients with diabetes. Diabetes Care 2009;32(7):1335–43.*



Adapted from ref 19

Fig. 2 – Differential diagnosis of DKA. Data adapted from ref [19].



**Table 3 – Laboratory evaluation of metabolic acidosis and coma.**

	Starvation or high fat intake	DKA	Lactic acidosis	Uremic acidosis	Alcoholic ketosis (starvation)	Salicylate intoxication	Methanol or ethylene glycol intoxication	Hyperosmolar coma	Hypoglycemic coma	Rhabdomyolysis	Isopropyl alcohol
pH	Normal	↓	↓	Mild ↓	↓↑	↓↑	↓	Normal	Normal	Mild ↓ may be ↓↓	Normal
Plasma glucose	Normal	↑	Normal	Normal	↓ or normal	Normal or ↓	Normal	↑↑ >500 mg/dl	↓↓ <30 mg/dl	Normal	↓
Glycosuria	Negative	++	Negative	Negative	Negative	Negative †	Negative	++	Negative	Negative	Negative
Total plasma ketones*	Slight ↑	↑↑	Normal	Normal	Slight to moderate ↑	Normal or	Normal	Normal or slight ↑	Normal or slight ↑	Normal	↑
Anion gap	Slight ↑	↑	↑	Slight ↑	↑	↑	↑	Normal	Normal or slight	↑↑	↑↑
Osmolality	Normal	↑	Normal	↑	Normal	Normal	↑↑	↑↑ >330 mOsm/kg	Normal	Normal or slight ↑	↑
Uric Acid	Mild (starvation)	↑	Normal	Normal	↑	Normal	Normal	Normal	Normal	↑	Normal
Miscellaneous	False-positive	May give lactate for ethylene glycol	Serum >200 >7 mmol/l	BUN mg/dl	salicylate	Serum levels positive	Serum positive		hemoglobinuria	Myoglobinuria	

# DKA vs HHS

- Etiology:
  - New onset ~ 20%
  - Non-adherence ~ 50% (recurrent DKA ~ 80%)
  - Infection ~ 15%
  - Other ~ 15%
    - stroke, MI, pancreatitis, medication effect (steroids), pregnancy, SGLT-2, insulin pump malfunction, antipsychotics (olanzapine, risperidone)
- Mortality:
  - <1% in DKA
  - 5-16% HHS

# Formulas

- Anion gap =  $(\text{Na} + \text{K}) - (\text{bicarb} + \text{chloride})$ .  
Abnormal  $> 12$ . [ abnormal  $> 10$  if  $\text{K}^+$  not included]
- Osmolar gap. Measured osmoles – calculated osmoles.
- Calculated osmoles =  $2(\text{Na}) + \text{K} + \text{BUN}/2.8 + (\text{glu}/18)$
- Corrected Na = Measured Na +  $\{1.6 \times [\text{glu} - 100]/100\}$ .
- Arterial pH =  $6.97 + (0.0163 \times \text{bicarbonate})$
  
- If corrected Na is normal range, then low measured Na is due to osmotic shifting. If corrected Na is below normal range, then Na is truly low due to osmotic diuresis. If measured Na is in the normal range without correction in the setting of significant hyperglycemia, this is likely due to loss free  $\text{H}_2\text{O}$ .
- Note: Pseudohyponatremia due to chylomicronemia

# Characterization of Diabetes

- Beta cell reserve: “ $\beta$ -”
  - C-Peptide in face of glucose > 200 mg/dl
- Autoimmunity: “A+”
  - GAD antibody [ZnT8 antibody]
  - ~~– Islet cell antibody~~
  - ~~– Anti-insulin antibody (Pedi only)~~
- HLA
  - DR3/DR4 + other genetic traits
- MODY genes

## Syndromes of Ketosis-Prone Diabetes Mellitus

Ashok Balasubramanyam, Ramaswami Nalini, Christiane S. Hampe, and Mario Maldonado

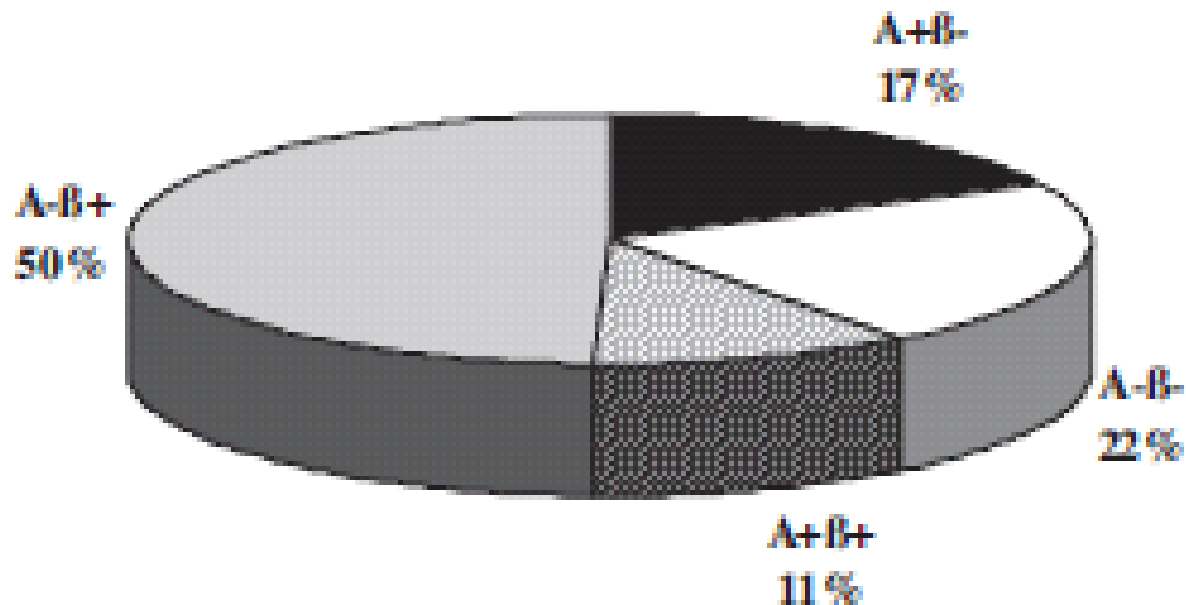


FIG. 1. Frequency distribution of patients in the four Aβ groups in a multiethnic adult U.S. urban population. [Reproduced with permission from M. Maldonado *et al.*: *J Clin Endocrinol Metab* 88:5090–5098, 2003 (1). Copyright The Endocrine Society.]

# Presentation- signs

Dehydration (hypovolemia by dry mucus membranes, decreased skin turgor, or by hypotension)

- Ketone breath (fruity odor)(acetoacidic acid -> converted to acetone -> removed via lungs)
- Kussamaul breathing (deep regular sigh respirations)

# Approach

- 1) Confirm diagnosis.
  - Usually blood glucose  $>250-300$ . Beware of euglycemic DKA.
  - $\text{pH} < 7.3$  (met acidosis w an anion gap)
  - Elevation in serum ketones  $> 3$ .
- 2) Initiate treatment in a 3 pronged manner.
  - Insulin deficient- supply insulin.
  - Fluid depleted- supply fluids.
  - Electrolyte derangements- correct.

- What rate do you start IVFs and what kind?
- When do you transition IVFs and what kind?
- How much IVF does the average DKA patient require?



# IV Fluids - 1

- Fluids:
  - Average DKA patient is 5-8L depleted upon presentation.
  - Give 1-2L NS bolus in 1<sup>st</sup> hour (usually done in ER but double check them!)
  - Goal is to replace ½ fluid deficit within first 8 hrs.
  - Don't forget about urine loss
  - Generally over hours 2-4, infuse NS at rate of 500 cc/hr
  - Technically when bp is stable and UOP is adequate, rate can be reduced to 250 cc/hr.
  - Type of fluid is changed to 1/2NS usually when bp and UOP are stable, or when Na > 155

# IV Fluids- 2

- Add 5% D5 to fluid when glucose  $< 250$ . (hormonal axis leading to hyperglycemia has not normalized and patient will experience worsening DKA without continued insulin).
- Continue glucose administration until ketosis (not ketonuria) clears and patient is able to tolerate po.
- If glucose  $< 150$  and pt is still ketotic, can change fluids to D10% or D20%.
- Fluid replacement alone:
  - Expands intravascular compartment as well as interstitial compartment (improves perfusion),
  - Leads to reduction in serum glucose levels alone (by as much as 25%)
  - Leads to less circulating hormones producing hyperglycemia

- What rate do you start insulin?
  - How fast should serum glucose fall?
  - Is it possible for serum glucose to fall too rapidly?
  - When can you stop IV insulin?
  - What are situations when you would delay starting insulin?
- 
- Research question: use of long acting insulin?

# Insulin-1

- Insulin:
  - Prime tubing with insulin.
  - Begin IV regular insulin infusion at rate 0.14 U/kg/hr (if no bolus).
  - IV regular insulin has a half life of 7-8 minutes. No interruptions should occur in drip (including transfer from ED to ICU) due to short half life.
  - Goal serum glucose fall 50-70 mg/dL (~ 10%) in 1<sup>st</sup> hr.
  - Adjust infusion rate until glucose is falling this much hourly.
  - If rate of glucose decline > 100 mg/dL/hr, decrease rate of insulin administration to avoid cerebral edema.
  - Continue infusion until serum ketosis (not ketonuria) resolves (< 3 mmol. If glucose, bicarbonate, anion gap have resolved but serum ketosis remains, pt will remain highly resistant to insulin, should consider continuing protocol until ketosis resolves.

# Insulin - 2

- Glucose levels should be monitored hourly.
- Target serum glucose initially 250 mg/dL.
- Insulin replacement alone-
  - Gluconeogenesis and ketone production in the liver are halted.
  - Lipolysis of adipose tissue is halted.
- Delay insulin replacement for:
  - Severely hypotensive patients. As insulin administration can lead to dramatic intravascular shift which can precipitate vascular collapse. Fluids first!
  - Severely hypokalemic patients. As insulin administration can lead to dramatic intravascular shift, and cardiac arrhythmias can occur with significant hypokalemia.

- Which electrolytes might merit replacement before administering insulin?

**Table 2**  
**Potassium repletion in DKA and HHS**

<b>Serum Potassium (mEq/L)</b>	<b>Repletion</b>
>5.3	No repletion, repeat in 1 h.
4.0–5.3	Add 10 mEq/L KCl/h to IV fluids.
3.5–<4.0	Add 20 mEq/L KCl/h to IV fluids.
<3.5	Hold insulin. Add 20–60 mEq/L/h to IV fluids, place on continuous cardiac monitor.

*Data from* McNaughton CD, Self WH, Slovis C. Diabetes in the emergency department: acute care of diabetes patients. *Clin Diabetes* 2011;29(2):51–9.

# Electrolytes

- Electrolytes:
  - Bicarbonate:
    - Generally does not need replacement.
    - Can consider if pH < 6.9 or bicarb < 5. Can replete by adding it to fluid 1-2 amps of bicarbonate in fluid. When pH reaches 7.0, stop, to avoid late alkalosis.
  - Phosphorus:
    - Repletion not normally required.
    - If phosphate < 1 or symptomatic, give 30-60 mM over 24 hrs.
    - ratio 2/3 potassium chloride : 1/3 potassium phosphate
    - Watch for hypocalcemia, hypomagnesium while repleting phosphate.
    - Symptoms of hypophosphatemia include: lethargy, depression, diarrhea, hemolytic anemia from lack of 2,3-diphosphoglycerate



# HHS Treatment

- Generally fluid administration is greater:
  - If patient is hypotensive, give 2L fluid in first hour, rather than 1L.
  - Serum osm < 320, give 2-3L bolus of NS in 1<sup>st</sup> hr. (rather than 1-2L)
  - If serum osm > 320, some suggest:
    - Give 1.5L hypotonic saline for 1<sup>st</sup> hr.
    - 1 L of hypotonic saline for 2<sup>nd</sup> and 3<sup>rd</sup> hrs.
    - 500-750 cc of hypotonic saline for 4<sup>th</sup> hr.
    - Thus after 4 hrs = 4.5 L or more of hypotonic saline.
    - Continue hypotonic saline administration until serum osm < 320.
    - However, this strategy is controversial as in these patients even normal saline tends to be hypotonic.
- Insulin is less important than fluid administration:
  - Patients tend to be quite sensitive to insulin. Can start insulin at 0.05 U/kg rather than 0.1 U/kg.
  - In severe hypotension, do not start insulin. This will exacerbate hypotension and will not have effective delivery of insulin until circulating volume is improved.
  - Fall of glucose not tracked as closely. Goal is to have decrease over 2-4 hrs. If this does not occur, double insulin infusion rate. (rather than decrease by 50-70 every hour)
  - When glucose falls < 250, can add D5 to IVFs or can ½ rate of insulin administration. (in DKA must add D5 cannot stop insulin infusion!)
- Complications:
  - Thrombosis more common. **MUST have heparin prophylaxis.**
  - Also DIC, rhabdomyolysis more common than DKA.

## 6 hours after admission

- Glucose 500 mg/dl
- ↓Serum ketones
- Na<sup>+</sup> 155, K<sup>+</sup> 3.9, Cl 105, HCO<sub>3</sub> 15, AG
- Cr 1.1, BUN 26
- Ca<sup>++</sup> 8.5, Phos 2.5, Albumin 4

# 12 hours after admission

- Glucose 350 mg/dl
- ↓Serum ketones
- Na<sup>+</sup> 155, K<sup>+</sup> 3.0, Cl 115, HCO<sub>3</sub> 12, AG
- Cr 1.1, BUN 26
- Ca<sup>++</sup> 8.0, Phos 2.0



# 18 hours after admission





- Glucose 200 mg/dl
- ↓Serum ketones
- Na<sup>+</sup> 148, K<sup>+</sup> 3.0, Cl 120, HCO<sub>3</sub> 12, AG
- Cr 0.9, BUN 18
- Ca<sup>++</sup> 8.0, Phos 2.0

## 24 hours after admission



















- Glucose 200 mg/dl
- Neg Serum ketones
- Na<sup>+</sup> 140, K<sup>+</sup> 3.4, Cl 115, HCO<sub>3</sub> 15, AG
- Cr 0.6, BUN 10
- Ca<sup>++</sup> 8.0, Phos 2.0
- Hungry, clinically improved

# MHH

Search:   Starts with  Type: 

    Folder: Search within:

---

 Insulin Infusion Orders for ICU MPP	 Insulin Level
  Insulin Management of Diabetes Pre-operative Orders M...	insulin lispro
  Insulin Sub-Q Orders for Patients on Oral Nutrition MPP	insulin lispro-insulin lispro protamine 25/75
  Insulin Sub-Q Orders for Patients on Parenteral/Enteral N...	insulin lispro-insulin lispro protamine 50/50
  Insulin TRANSITION IV to Sub-Q for ICU Patients on Oral ...	Insulin regular
  Insulin TRANSITION IV to Sub-Q for ICU Patients on Pare...	Insulin Regular (1 unit/ml) Pediatric DKA >10 kg
 Insulin-like Growth Factor 1	Insulin Regular (1 unit/ml) Pediatric DKA <10 kg
 Insulin-Like Growth Factor II	insulin regular 100 units/mL human recombinant
Insulin (R) 100 unit in NS 100 ml (DKA titrate) IV	insulin regular human recombinant 500 units/mL injectable sol...
Insulin (R) 100 unit in NS 100ml (ICU Titrate) IV	Insulin regular PICU (0.5 units/mL) < 10 kg
Insulin (R) 100 unit in NS 100ml (Titrate) IV	Insulin regular PICU (1 unit/mL) > 10 kg
 Insulin Antibody	 Insulin Timed Study
insulin aspart	 Insulinoma Antigen 2
insulin aspart-insulin aspart protamine 30/70	
insulin detemir	
Insulin Drip Protocol	
insulin glargine	
 insulin glulisine	
insulin isophane	
insulin isophane-insulin regular 50/50	
insulin isophane-insulin regular 70/30	
insulin isophane-NPH	

# MHH – Atlanta protocol

Component	Status	Details
<b>Insulin Infusion Orders for ICU MPP (Planned Pending)</b>		
Laboratory		
<input checked="" type="checkbox"/> Point of Care Blood Glucose AC4		T;N, Routine, Q1H Use whole blood (NOT fingerstick sample) when a patient is on vasopressor (epinephrine, isoproterenol, phen...
<input checked="" type="checkbox"/> Potassium Level		T;N, Timed Study, Q8H, 48, hr
Medications		
Consider Endocrinology consult if patient has frequent episodes of hypoglycemia (FBG < = 60 mg/dl), hyperglycemia (FBG > = 200 mg/dl), or HA1c > = 8.5%.		
<b>ICU INSULIN INFUSION FOR CRITICALLY ILL PATIENTS</b>		
<b>*****NOT FOR PATIENTS WITH DIABETIC KETOACIDOSIS OR HYPERGLYCEMIC HYPEROSMOLAR STATE*****</b>		
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		LOW Target= 110 mg/dL and HIGH Target= 180mg/dL
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		Do Not Start Insulin Drip Unless Potassium is More Than 3.3 mEq/L.
<input checked="" type="checkbox"/> Insulin (R) 100 unit in NS 100ml (ICU Titrate) IV		99 mL, Rate: Start Insulin Drip Per ICU Protocol, kg, Route: IVPB, Replace Every: 24 hr Use Atlanta Insulin Infusion Protocol on the Clinical Calculator. Initial Insulin Drip Rate (units/hour)=(Fasting ...
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		Insulin (R) 100 unit in NS 100ml (ICU Titrate) IV
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		Details: 99 mL, Rate: Start Insulin Drip Per ICU Protocol, kg, Route: IVPB, Replace Every: 24 hr
<input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)		Order Comment: Use Atlanta Insulin Infusion Protocol on the Clinical Calculator. Initial Insulin Drip Rate (units/hour)=(Fasting Blood Glucose-60)X0.03 "multiplier". If hourly FBG is greater than HIGH target, increase the "multiplier" by 0.01. (Do Not increase if treated for hypoglycemia within the last 4 hours.); If hourly FBG is less than LOW target, decrease the "multiplier" by 0.01; If hourly FBG is WITHIN target range, do NOT change the "multiplier". Discontinue All Previous Insulin Orders and Oral Hypoglycemic Agents ***For ICU Use Only***
<input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)		
<input checked="" type="checkbox"/> Notify MD		
<input checked="" type="checkbox"/> Notify MD		
<input checked="" type="checkbox"/> Notify MD		

# MHH – DKA protocol

Search:  Starts with  Folder: Search with

**DKA Orders MPP**

Status	Details
	reater than 3 mEq/L.
<input type="checkbox"/>	<p>Loading Dose:</p> <p><input checked="" type="checkbox"/> Insulin regular 0.1 unit/kg, Route: IVP, ONCE, Priority: STAT</p> <p>Maintenance Dose:</p> <p>DO NOT uncheck the Insulin Infusion order from this MPP when transitioning from the ED to Inpatient DKA Orders</p> <p><input checked="" type="checkbox"/> Insulin (R) 100 unit in NS 100ml (Titrate) IV 99 mL, Rate: Titrate, kg, Route: IV, Priority: Routine, Replace Every: 24 hr Start insulin infusion 0.1 unit/kg/hr = 0.1 unit/kg/hr X ___ kg= ___ units/hr (IF NO LOADING DOSE IS GIVEN: Start ...</p> <p><input checked="" type="checkbox"/> Notify MD</p> <p><input checked="" type="checkbox"/> Hypoglycemia Orders (BG &lt; or = 60 mg/dL)</p> <p><input checked="" type="checkbox"/> MD to Nurse Order, Misc</p> <p><input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)</p> <p><input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)</p> <p><input checked="" type="checkbox"/> glucagon</p> <p>Miscellaneous</p> <p><input checked="" type="checkbox"/> DKA Electrolyte Replacement MPP Planned Pen...</p> <p><input checked="" type="checkbox"/> Patient Care (MD to Nurse)</p> <p><input checked="" type="checkbox"/> MD to Nurse Order, Misc</p> <p><input checked="" type="checkbox"/> MD to Nurse Order, Misc</p> <p><input checked="" type="checkbox"/> MD to Nurse Order, Misc</p> <p><input checked="" type="checkbox"/> Notify MD</p> <p><input checked="" type="checkbox"/> Patient Education AC4</p> <p><input checked="" type="checkbox"/> Diabetes Nurse Educator Consult - Adult</p> <p><input checked="" type="checkbox"/> Non Categorized</p> <p><input checked="" type="checkbox"/> CDM DKA Orders</p>
	<p>Details:</p> <p>99 mL, Rate: Titrate, kg, Route: IV, Priority: Routine, Replace Every: 24 hr</p> <p>Order Comment: Start insulin infusion 0.1 unit/kg/hr = 0.1 unit/kg/hr X ___ kg= ___ units/hr (IF NO LOADING DOSE IS GIVEN: Start insulin infusion at 0.14 unit/kg/hr = 0.14 unit/kg/hr X ___ kg= ___ units/hr)</p> <p>STEP 1: Utilize when BG &gt; 250 mg/dL and patient is on NS. Check BG fingerstick hourly after start of infusion (if BG &lt;= 250 mg/dL, skip to STEP 2). Once reach Step 2, do not go back to Step 1 regardless of BG. *If fingerstick BG &gt; 400, RN must confirm BG with blood draw*, continue fluid replacement per MD order (see continuous IV fluid orders). *Contact MD if insulin rate is &gt;= 20 units/hr*</p> <p>If BG decreases by &lt; 50 mg/dL OR Increases, double the insulin infusion rate to a Max rate of 20 units/hr. Contact MD if new rate is &gt;= 20 units/hr and/or if BG increases by &gt; 150 mg/dL. If BG decreases by 50-100 mg/dL, NO CHANGE in Infusion Rate. If BG decreases by &gt; 100 mg/dL and BG &gt; 400, continue infusion rate. If BG decreases by &gt; 100 mg/dL and BG &lt; 400, notify MD.</p> <p>STEP 2: Utilize when patient glucose is FIRST below or equal to 250 mg/dL and patient on IV Fluid with dextrose. Once reach Step 2, do not go back to Step 1 regardless of BG. Change IV fluids as ordered (see continuous IV fluid orders for D5W/NS), continue checking BG fingerstick hourly. *Contact MD if BG &gt; 400 or insulin rate is &gt;= 20 units/hr* *If fingerstick BG is &gt; 400, RN must confirm BG with blood draw* If BG &lt;= 60, contact MD (see hypoglycemia orders) If BG &lt;= 80, contact MD and HOLD insulin drip, check fingerstick BG every 15 minutes after infusion stopped. Restart insulin drip after fingerstick BG &gt; 90. Decrease insulin infusion rate by 50%. Start D10W per MD order. *If insulin infusion is discontinued or turned off, restart insulin at 50% previous rate and follow</p>

Dx Table Save as My Favorite

Initiate Sign

OD P1060903 06/29/2015 11:17



# LBJ

Name	Type	Pref List	Code	Dose	Route	Frequen
INSULIN						
ADULT INSULIN **OPEN ORDERSET**	Medicatic	HCHD	IP	AD		
Insulin	Lab	IP	CPOE	LAI	INSC	
insulin NPH (HumuLIN N) injection	Medicatic	HCHD	IP	AD		
insulin NPH-regular (NovoLIN 70-30) injection	Medicatic	HCHD	IP	AD		
insulin asp prot-insulin asp (NovoLOG MIX 70/30 FLEXPEN) pen	Medicatic	HCHD	IP	AD		
insulin aspart (NovoLOG FLEXPEN) pen	Medicatic	HCHD	IP	AD		
insulin aspart (NovoLOG) injection	Medicatic	HCHD	IP	AD		
insulin detemir (LEVEMIR FLEXPEN) pen	Medicatic	HCHD	IP	AD		
insulin detemir (LEVEMIR) injection	Medicatic	HCHD	IP	AD		
insulin glargine (LANTUS) injection	Medicatic	HCHD	IP	AD		
insulin lispro (HumaLOG) injection	Medicatic	HCHD	IP	AD		
insulin regular (HumuLIN R) injection	Medicatic	HCHD	IP	AD		
insulin regular (NovoLIN R) IV drip	Medicatic	HCHD	IP	AD		

 Please select appropriate order set for the patient to proceed.

- Open Order Set: Adult Insulin Drip/Infusion Orders [preview](#)
- Open Order Set: Adult Subcutaneous Insulin Orders [preview](#)
- Open Order Set: Adult DKA and HHS Insulin Orders [preview](#)
- Open Order Set: Adult OB/Gyn Insulin orders [preview](#)

# LBJ – insulin DKA

If blood glucose > 200 mg/dl in DKA or > 300 mg/dl in HHS, add Dextrose to IV (select appropriate record below)  
 For blood glucose < 100 mg/dl, consider using Dextrose 10 % + 0.9 % NaCl order below.

<input type="checkbox"/> 0.9% NaCl infusion STAT (if not cardiac compromised or susceptible to fluid overload, recommend 15-20 ml/kg/hr)	Intravenous, ONCE Starting today For 1 Doses, STAT
<input type="checkbox"/> 0.9% NaCl infusion (maintenance)	Intravenous, CONTINUOUS Starting today For 30 Days, Routine
<input type="checkbox"/> D5W -0.9 % NaCl infusion (when Blood Glucose is less than 200 mg/dL)	Intravenous, CONTINUOUS Starting today For 30 Days, Routine
<input type="checkbox"/> D5W-LR infusion (when Blood Glucose is less than 200 mg/dL)	Intravenous, CONTINUOUS Starting today For 30 Days, Routine
<input type="checkbox"/> D10W - 0.9 % NaCl infusion (when Blood Glucose falls to less than 100 mg/dL)	Intravenous, CONTINUOUS Starting today For 30 Days, Routine

## Insulin Orders

Please remember to Discontinue all previous insulin orders and/or oral diabetes medications  
 Recommended titrations are based on fingerstick blood glucose (BG), and performed by nursing

[DKA/HHS Nursing Guidelines](#) URL: [http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/DKA\\_HHS\\_NursingGuidelines.pdf](http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/DKA_HHS_NursingGuidelines.pdf)

<input type="checkbox"/> Give one-time dose of specified Regular Insulin IV push prior to initiating insulin infusion (suggest 0.1 unit/kg)	IV Push, ONCE Starting today For 1 Doses, Routine
<input type="checkbox"/> Start hourly infusion of Regular Insulin at specified rate (suggest 0.1 unit/kg/hr)	Intravenous, AS DIRECTED For 30 Days, Routine
<input type="checkbox"/> Insulin REGULAR bolus if blood glucose does not decrease by 75 mg/dL in one hour	IV Push, PRN For 30 Days, Other, Only give when blood glucose does not decrease by 75 mg/dL in one hour, Routine
<input checked="" type="checkbox"/> If BG does not decrease by 75 mg/dL in any hour, give bolus Regular Insulin with no rate change	IV Push, PRN For 30 Days, Other, Routine

## Potassium Replacement

--It is recommended to select potassium supplementation order below that has the same base fluid as selected in the IV Fluids section.

--Orders that have more than 20 mEq of KCl per liter will have to be prepared by the inpatient pharmacy and delivered. You may enter an order with > 20 mEq KCl in the search field at the bottom of this order set.

<input checked="" type="checkbox"/> If potassium <= 3.3 mEq/L give KCl as needed (limit 10 mEq per hour peripherally)	10 mEq, Intravenous, PRN For 30 Days, Other, See administration instruction, Routine
<input checked="" type="checkbox"/> If potassium is 3.3 to 5.3 mEq/L give KCl as needed (limit 10 mEq per hour peripherally)	10 mEq, Intravenous, PRN For 30 Days, Other, See administration instruction, Routine
<input checked="" type="checkbox"/> Potassium > 5.3 mEq/L: recheck potassium in 2 hours and change all IVs to solutions without KCl added	Routine, UNTIL DISCONTINUED, Starting today, DKA/HHS Protocol: If Potassium > 5.3 mEq/L: recheck potassium in 2 hours and change all IVs to solutions without KCl added
<input type="checkbox"/> potassium chloride (KLOR-CON) 20 mEq oral packet	Oral, ONCE For 1 Doses, Routine

## Medications

### Hypoglycemia Medication Orders

[Hypoglycemia Management Protocol](#)

URL: <http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Hypoglycemia>

# LBJ – insulin gtt

[Adult Insulin Infusion/Drip Guidance](#)

**URL:** [http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Adult Insulin Drip Guidance.pdf](http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Adult%20Insulin%20Drip%20Guidance.pdf)

## General

### Notify Physician

<input checked="" type="checkbox"/> Notify physician	Routine, UNTIL DISCONTINUED, Starting today Physician pager number: Notify physician BEFORE starting insulin if serum potassium is 3.3 mEq/L or lower
<input checked="" type="checkbox"/> Notify physician	Routine, UNTIL DISCONTINUED, Starting today Physician pager number: Notify physician if blood glucose reverts to higher than 200 mg/dL x 2 consecutive tests after patient is at target blood glucose level

### Nursing Assessment

<input checked="" type="checkbox"/> POCT Glucose	Routine, 1 TIME, Starting today, between 15 and 30 minutes after treatment of hypoglycemia
<input checked="" type="checkbox"/> POCT Glucose	Routine, AS PER ORDER COMMENT, Starting today, every hour until blood glucose remains in target for 4 consecutive hours, then fingerstick glucose every 2 hours
<input checked="" type="checkbox"/> POCT Glucose	Routine, EVERY 1 HOUR, Starting today, if blood glucose is above target

## Labs

### Common Labs

<input type="checkbox"/> Hemoglobin A1C	Routine, AM DRAW, Starting tomorrow For 1 Occurrences, with next blood draw (once per hospital admission)
---	---

## Medications

### Medication Orders

Discontinue all previous insulin orders and oral diabetes medications  
Select Target BG range based on guidance from linked dosing charts

<input type="checkbox"/> insulin regular human 100 Units in 0.9% NaCl 100 mL IV drip	Intravenous, TITRATABLE-SEE ADMIN INSTR. Starting today For 30 Days, Routine
<input type="checkbox"/> If TPN interrupted, immediately start 10% Dextrose in 0.45 % NaCl @ 100 ml/hr	at 100 mL/hr, Intravenous, AS DIRECTED, Routine
<input type="checkbox"/> If TPN interrupted, immediately start 10% Dextrose in 0.225 % NaCl @ 100 ml/hr	at 100 mL/hr, Intravenous, AS DIRECTED, Routine

### Hypoglycemia Management Orders

[Hypoglycemia Management Protocol](#)

**URL:** [http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Hypoglycemia Management.pdf](http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Hypoglycemia%20Management.pdf)

<input checked="" type="checkbox"/> dextrose 50 % injection	IV Push, PRN For 30 Days, Other, See Admin Instruction, Routine
---	---

## Mild DKA Pilot

### Eligibility Criteria

1. Blood glucose > 250 mg/dL
2. pH > 7.25
3. HCO<sub>3</sub> > 15
4. BOHB or serum ketones < 3

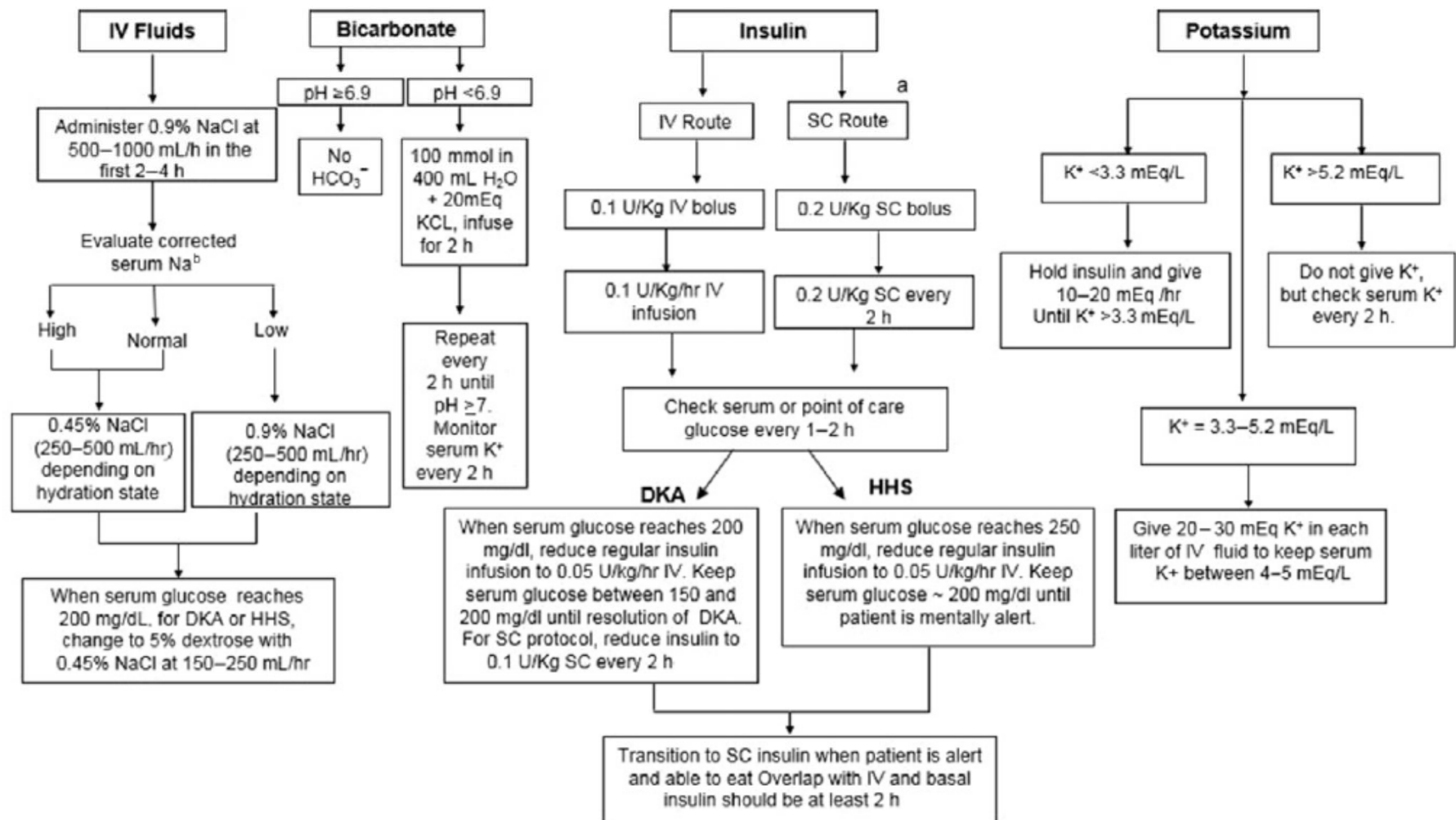
### Exclusion Criteria

1. Age ≥ 80 years
2. Altered Mental Status
3. Acute Myocardial Infarction
4. Congestive Heart Failure (NYHA Class III or IV)
5. Pregnancy
6. EGFR < 45 ml/min
7. MAP < 65
8. Severe Pancreatitis
9. Anasarca

## Insulin Aspart/Lispro

<b>Initial Bolus</b>	0.3 units/kg SC x 1 dose (max dose of 30 units)
<b>Blood glucose ≥ 250 mg/dL</b>	0.2 units/kg SC every 2 hours (max dose of 20 units)
<b>Blood glucose is &lt; 250 mg/dL</b>	0.1 units/kg SC every 2 hours (max dose of 10 units)

# Fayfman et al



- How do you determine insulin dose when transitioning from iv insulin to sc?

# Transitioning insulin to sc

- Overlap IV administration and subcutaneous administration is necessary due to short half life of IV insulin and delay in start of subcutaneous insulin. **Give Both long + short acting insulin**
- Time of overlap depends on insulin being used:
  - Regular insulin begins working subcutaneously 30-45 min.
  - Intermediate acting insulin (NPH) begins working subcutaneously 2-3 hrs.
  - Long acting insulin (glargine/detemir) begins working subcutaneously 3-4 hrs.
- To transition:
  - 1) Calculate total daily dose (TDD).
    - When insulin rate is stable for 4-6 hrs when pt NPO. Then take hourly rate of insulin drip x 20  
For Basal insulin only
  - 2) **Weight based formula- Preferred Method.**
    - **0.6U insulin/kg of body weight – May need higher rates if patient still under increased stress (infection).**

# Transitioning IV insulin to SC

- Once the daily dose is determined must further divide dose.
- There are multiple strategies:
  - If pt is eating:
    - Basal bolus regimen with scheduled premeal + correction
  - If the patient is not eating:
    - Q 6 hour dose; consider 70/30 if on tube feedings





# MHH – when NPO/TFs

+ Add to Phase ▾ Start:  ... Duration:  ...

	Component	Status	Details
<b>Insulin Sub-Q Orders for Patients on Parenteral/Enteral Nutrition or NPO MPP (Planned Pending)</b>			
Medications			
	Do NOT use for patients being converted from Insulin drips		
<input checked="" type="checkbox"/>	MD to Nurse Order, Misc		Discontinue all previous insulin orders.
<input checked="" type="checkbox"/>	Point of Care Blood Glucose AC4		T;N, Routine, Q6H
<input checked="" type="checkbox"/>	Notify MD		Notify MD for blood glucose > 300mg/dl or < 60 mg/dl.
<input checked="" type="checkbox"/>	Notify MD		Notify MD if patient becomes NPO or if Parenteral/Enteral nutrition stopped (review insulin orders).
	**SCHEDULED BASAL INSULIN (Please select one)**		
	Daily Basal Insulin recommended for patients with HA1c greater than 8% or average blood glucose > 200 mg/dL		
	Start with 0.2 units/kg/day (MAX 30 to 40 units)		
	If glucose is persistently above target, consider Increasing Basal dose by 20%		
<input type="checkbox"/>	insulin detemir		unit, Route: SUB-Q, Daily Do not hold insulin without contacting the prescriber.
<input type="checkbox"/>	insulin glargine		unit, Route: SUB-Q, Daily Do not hold insulin without contacting the prescriber.
<input type="checkbox"/>	insulin isophane (insulin isophane-NPH)		unit, Route: SUB-Q, Q8H Do not hold insulin without contacting the prescriber.
	***INSULIN CORRECTION DOSES***		
<input type="checkbox"/>	Aspart (Novolog) for Parenteral/Enteral or NPO Startin...		
<input type="checkbox"/>	Aspart (Novolog) for Parenteral/Enteral or NPO Mediu...		
<input type="checkbox"/>	Aspart (Novolog) for Parenteral/Enteral or NPO High ...		
<input type="checkbox"/>	Regular Insulin for Parenteral/Enteral or NPO Starting ...		
<input type="checkbox"/>	Regular Insulin for Parenteral/Enteral or NPO Medium...		
<input type="checkbox"/>	Regular Insulin for Parenteral/Enteral or NPO High Cor...		

# MHH – hypoglycemic protocol

***Hypoglycemia Orders***		
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> MD to Nurse Order, Misc	Hypoglycemia Orders (BG < or = 60 mg/dL): See Order Comments Review medications for management of BG < or = 60 mg/dL. For BG 40-60 mg/dL and patient AWAKE...
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)	25 mL, Route: IVP, PRN, PRN Blood Glucose Results For patients that are Unconscious or Unable to Swallow or NPO, if Blood Glucose 40-60 mg/dL
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)	50 mL, Route: IVP, PRN, PRN Blood Glucose Results if Blood Glucose < 40 mg/dL
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> glucagon	1 mg, Route: IM, PRN, PRN Blood Glucose Results For BG < 60 mg/dL if no IV access and patient is either Unconscious, unable to swallow or npo
Patient Care (MD to Nurse)		
<input type="checkbox"/>	<input checked="" type="checkbox"/> Patient Education AC4	Daily, Instructions: Allow/instruct patient to self administer insulin.
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Point of Care Blood Glucose AC4	q10-15min Until Blood Glucose is > 100 mg/dL
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Notify MD	
Consults		
<input type="checkbox"/>	<input checked="" type="checkbox"/> Nutrition Consult/Dietitian Consult (Consult Nutrition/Dietitian)	

# LBJ – insulin subq

## Medications

- Please select an IV solution to reduce the risk of hypoglycemia should the tube feeding or TPN be interrupted

### Basal Insulin Orders

Please select an IV solution to reduce the risk of hypoglycemia if the patient is made NPO after receiving basal insulin  
Physician should evaluate need to discontinue previous basal insulin orders. This can be done in the Medications Activity.  
Insulin glargine (Lantus) or 70/30 should only be used in patients taking insulin at home.

Suggested basal insulin for naive patients:

- o 0.2 units per kg per day for diabetes in 2 divided doses
- o units per kg per day if not previously diagnosed or ESRD in 2 divided doses

<input type="checkbox"/>	insulin NPH (NovoLIN N) 100 unit/mL injection BREAKFAST	Subcutaneous, DAILY WITH BREAKFAST For 30 Days, Routine
<input type="checkbox"/>	insulin NPH (NovoLIN N) 100 unit/mL injection BEDTIME	Subcutaneous, AT BEDTIME Starting today at 9:00 PM For 30 Days, Routine
<input type="checkbox"/>	insulin glargine (LANTUS) 100 unit/mL injection	Subcutaneous, Routine
<input type="checkbox"/>	insulin 70-30 (NOVOLIN) NPH and regular 100 unit/mL injection BREAKFAST	Subcutaneous, EVERY MORNING BEFORE BREAKFAST For 30 Days, Routine
<input type="checkbox"/>	insulin 70-30 (NOVOLIN) NPH and regular 100 unit/mL injection SUPPER	Subcutaneous, EVERY EVENING BEFORE DINNER For 30 Days, Routine
<input type="checkbox"/>	If patient made NPO after receiving morning Basal insulin, start D5W @ 100 ml/hr	Intravenous, at 100 mL/hr, AS DIRECTED For 30 Days, Routine
<input type="checkbox"/>	If patient made NPO after receiving morning Basal insulin, start D5W + 0.45 % NaCl @ 100 ml/hr	at 100 mL/hr, Intravenous, AS DIRECTED For 30 Days, Routine

### Pre-meal Insulin Orders

Provider should evaluate need to discontinue previous pre-meal insulin orders. This can be done in the Medications Activity.

<input type="checkbox"/>	insulin regular (HUMULIN R) 100 unit/mL injection	Subcutaneous, Routine
<input type="checkbox"/>	insulin lispro (HumaLOG) 100 unit/mL injection	Subcutaneous, Routine

### Fixed Interval Insulin

For patients on Enteral or Parenteral Feedings

Provider should evaluate need to discontinue previous fixed interval insulin orders. This can be done in the Medications Activity.

Please select only one order.

<input type="checkbox"/>	insulin NPH HUMAN (NOVOLIN N) 100 unit/mL injection	Subcutaneous, EVERY 12 HOURS For 30 Days, Routine
<input type="checkbox"/>	insulin regular human (NOVOLIN R) 100 unit/mL injection (suggest every 6 hours)	Subcutaneous, Routine
<input type="checkbox"/>	Give D10%W infusion @ 100 ml/hr if feeding or TPN interrupted	Intravenous, at 100 mL/hr, AS DIRECTED For 30 Days, Routine
<input type="checkbox"/>	Give D10 % + NaCl infusion @ 100 ml/hr if feeding or TPN interrupted (must select NaCl concentration)	at 100 mL/hr, Intravenous, AS DIRECTED, Routine

### Correction (Supplemental) Insulin Orders to cover blood glucose (NOT for bedtime use)

Provider should evaluate need to discontinue previous insulin correction orders. This can be done in the Medications Activity.

When selecting a medication, please indicate if insulin should be administered as pre-meal PRN (NOT for bedtime) or at a specified interval PRN.

If pre-meal insulin ordered, consider using same insulin type for correction.

Notify physician team before giving if patient is NPO

<input type="checkbox"/>	insulin regular human (NOVOLIN R) 100 unit/mL injection	Subcutaneous, Routine
<input type="checkbox"/>	insulin lispro (HumaLOG) 100 unit/mL injection (requires FCC Approval)	Subcutaneous, Routine

### Correction (Supplemental) Insulin Orders BEDTIME ONLY

Provider should evaluate need to discontinue previous insulin correction orders. This can be done in the Medications Activity.

If pre-meal insulin ordered, consider using same insulin type for correction.

Includes orders for both pm and bedtime correction

Notify physician team before giving if patient is NPO

<input type="checkbox"/>	insulin regular human (NOVOLIN R) 100 unit/mL injection	Subcutaneous, BEDTIME PRN For 30 Days, Other, See Administration Instruction, Routine
<input type="checkbox"/>	insulin lispro (HumaLOG) 100 unit/mL injection (requires FCC Approval)	Subcutaneous, BEDTIME PRN For 30 Days, Other, See Administration Instruction, Routine

### Hypoglycemia Medication Orders

[Hypoglycemia Management Protocol](#)

URL: <http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Hypoglycemia Management.pdf>

<input checked="" type="checkbox"/>	dextrose (INSTA-GLUCOSE) 40 % oral jel	Oral, PRN For 30 Days, Other, Administer per Standing Orders for Hypoglycemia Management, Routine
<input checked="" type="checkbox"/>	glucagon (human recombinant) (GLUCAGEN) injection	1 mg, Intramuscular, PRN For 30 Days, Administer per Standing Orders for Hypoglycemia Management, Routine
<input checked="" type="checkbox"/>	dextrose 50 % injection	IV Push, PRN For 30 Days, Administer per Standing Orders for Hypoglycemia Management, Routine

# Complications

- Cerebral edema:
  - With excessively rapid correction of Na and osmolarity, cerebral edema can occur. Exact etiology not known.
  - More common in pediatric patients, but can occur in adults.
  - Presents as headache, deterioration in consciousness or LOC, seizures.
  - Treat with mannitol (1-2 gm/kg to load), steroids, loop diuretics.
  - These patients tend not to survive.
- ARDS
- Embolism
  - DKA is hypercoaguable state.
- Acute gastric dilation (from excess prostaglandins)
  - Treat with reglan.

# Sick Day Management

## DM Type 1

- Continue background insulin
- Monitor ketones if Glucose > 250 mg/dl
- Maintain hydration
- **\*\*Continue caloric intake with rapid insulin**
- Treatment of underlying stressor/infection
- Treatment of nausea
- Close contact with health care provider

# Alcoholic Ketoacidosis

- Nausea/vomiting + abdominal pain
- EtOH level - undetectable
- 75% pancreatitis
- Glucose usually  $< 150$  mg/dl, 15%  $< 50$  mg/dl
- Acidosis with increased anion gap, predominantly  $\beta$ -OH butyrate
- Treatment: IV dextrose, thiamine  $\pm$  insulin

# Common Errors in Treatment of DKA

- Slow recognition (especially if glucose < 400)
- Inadequate or intermittent initial therapy
- Inadequate K<sup>+</sup> replacement
- Inappropriate Phosp replacement
- Early decrease or termination of insulin
- Poor transition to SQ insulin



- What are current recommendations for glucose targets in non-DKA patients?
- Are they different among surgical and medical patients, if so- how do they differ?

# The New England Journal of Medicine

Copyright © 2001 by the Massachusetts Medical Society

VOLUME 345

NOVEMBER 8, 2001

NUMBER 19



## INTENSIVE INSULIN THERAPY IN CRITICALLY ILL PATIENTS

GREET VAN DEN BERGHE, M.D., PH.D., PIETER WOUTERS, M.Sc., FRANK WEEKERS, M.D., CHARLES VERWAEST, M.D.,  
FRANS BRUYNINCKX, M.D., MIET SCHETZ, M.D., PH.D., DIRK VLASSELAERS, M.D., PATRICK FERDINANDE, M.D., PH.D.,  
PETER LAUWERS, M.D., AND ROGER BOUILLON, M.D., PH.D.

*The* NEW ENGLAND  
JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

FEBRUARY 2, 2006

VOL. 354 NO. 5

## Intensive Insulin Therapy in the Medical ICU

Greet Van den Berghe, M.D., Ph.D., Alexander Wilmer, M.D., Ph.D., Greet Hermans, M.D.,  
Wouter Meersseman, M.D., Pieter J. Wouters, M.Sc., Ilse Milants, R.N., Eric Van Wijngaerden, M.D., Ph.D.,  
Herman Bobbaers, M.D., Ph.D., and Roger Bouillon, M.D., Ph.D.

*The* NEW ENGLAND  
JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

MARCH 26, 2009

VOL. 360 NO. 13

## Intensive versus Conventional Glucose Control in Critically Ill Patients

The NICE-SUGAR Study Investigators\*

# MHH – Atlanta protocol

Component	Status	Details
<b>Insulin Infusion Orders for ICU MPP (Planned Pending)</b>		
Laboratory		
<input checked="" type="checkbox"/> Point of Care Blood Glucose AC4		T;N, Routine, Q1H Use whole blood (NOT fingerstick sample) when a patient is on vasopressor (epinephrine, isoproterenol, phen...
<input checked="" type="checkbox"/> Potassium Level		T;N, Timed Study, Q8H, 48, hr
Medications		
Consider Endocrinology consult if patient has frequent episodes of hypoglycemia (FBG < = 60 mg/dl), hyperglycemia (FBG > = 200 mg/dl), or HA1c > = 8.5%.		
ICU INSULIN INFUSION FOR CRITICALLY ILL PATIENTS		
*****NOT FOR PATIENTS WITH DIABETIC KETOACIDOSIS OR HYPERGLYCEMIC HYPEROSMOLAR STATE*****		
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		LOW Target= 110 mg/dL and HIGH Target= 180mg/dL
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		Do Not Start Insulin Drip Unless Potassium is More Than 3.3 mEq/L.
<input checked="" type="checkbox"/> Insulin (R) 100 unit in NS 100ml (ICU Titrate) IV		99 mL, Rate: Start Insulin Drip Per ICU Protocol, kg, Route: IVPB, Replace Every: 24 hr Use Atlanta Insulin Infusion Protocol on the Clinical Calculator. Initial Insulin Drip Rate (units/hour)=(Fasting ...
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		Insulin (R) 100 unit in NS 100ml (ICU Titrate) IV
<input checked="" type="checkbox"/> MD to Nurse Order, Misc		Details: 99 mL, Rate: Start Insulin Drip Per ICU Protocol, kg, Route: IVPB, Replace Every: 24 hr
<input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)		Order Comment: Use Atlanta Insulin Infusion Protocol on the Clinical Calculator. Initial Insulin Drip Rate (units/hour)=(Fasting Blood Glucose-60)X0.03 "multiplier". If hourly FBG is greater than HIGH target, increase the "multiplier" by 0.01. (Do Not increase if treated for hypoglycemia within the last 4 hours.); If hourly FBG is less than LOW target, decrease the "multiplier" by 0.01; If hourly FBG is WITHIN target range, do NOT change the "multiplier". Discontinue All Previous Insulin Orders and Oral Hypoglycemic Agents ***For ICU Use Only***
<input checked="" type="checkbox"/> Dextrose 50% in Water IV (Dextrose 50% Syringe)		
<input checked="" type="checkbox"/> Notify MD		
<input checked="" type="checkbox"/> Notify MD		
<input checked="" type="checkbox"/> Notify MD		

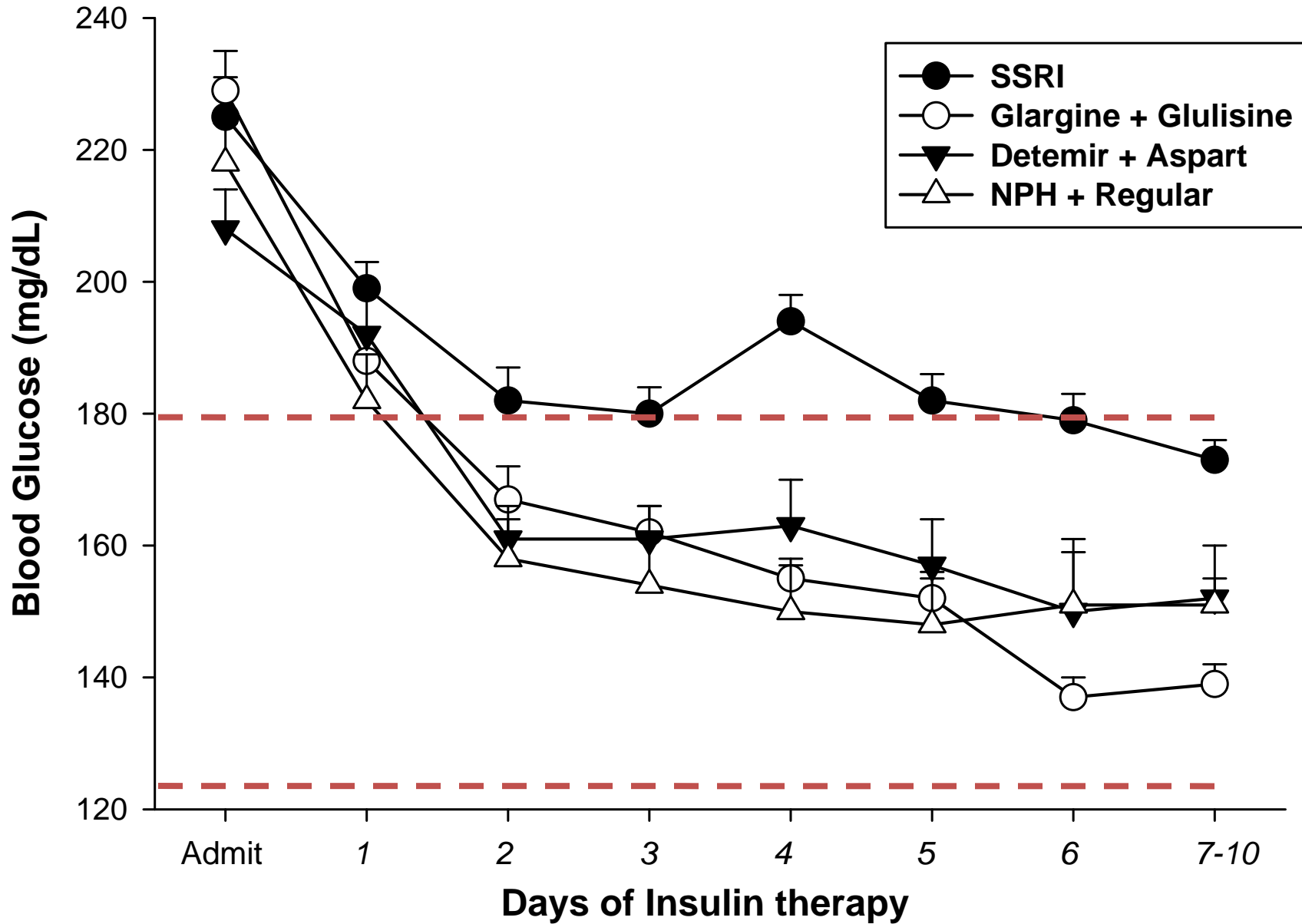
# Atlanta Protocol

- Glucose – 60 X Conversion Factor (0.03)
- If glucose not at target, increase conversion factor by 0.01. If glucose below target, reduce conversion factor by 0.01
- Example;
  - Glucose 260 – 60 X 0.03 = 6 units/hour
  - Glucose 260 – 60 X 0.04 = 8 units/hour
  - Glucose 300 – 60 X 0.05 = 12 units/hour

# Atlanta Protocol

- Not for patients that are eating – would transition to SQ insulin regimen
- Not for patients with Type 1 diabetes

## Basal Bolus versus SSRI – non-ICU



# Insulin sliding scale:

---

- Patient receives short-acting insulin only if their glucose is elevated
- Reactive therapy rather than proactive
  - Ex: Take your b

BG (mg/dL)	□ Individual
150-199	units
200-249	units
250-299	units
300-349	units
349 or greater	units



□ High Dose	□ Bed Time Dose
3 units	NONE
6 units	1 unit
9 units	2 units
12 units	3 units
15 units	4 units

4. SCHEDULED PREMEAL INSULIN

**Start 0.05 units/kg = 4 units AC**

- Insulin, aspart (Novolog) administered immediately prior to meals

Before Breakfast	Before Lunch	Before Dinner
___ units Sub-Q	___ units Sub-Q	___ units Sub-Q

5. CORRECTION DOSES: Given PRN Glucose Results in addition to scheduled basal and premeal insulin if applicable

- Insulin, aspart (Novolog) immediately prior to meals **OR**
- Insulin, regular (Novolin R, Humulin R) 15-30 minutes prior to meals

BG (mg/dL)	<input type="checkbox"/> Individual	<input type="checkbox"/> Starting Dose	<input type="checkbox"/> Medium Dose	<input type="checkbox"/> High Dose
150-199	units	1 unit	2 units	3 units
200-249	units	2 units	4 units	6 units
250-299	units	3 units	6 units	9 units
300-349	units	4 units	8 units	12 units
349 or greater	units	5 units	10 units	15 units
Other _____	units			



Note: LBJ scale is different

6. HYPOGLYCEMIA (BG < 60 mg/dL)

BG (mg/dL)	AWAKE/ALERT and able to swallow	UNCONSCIOUS or unable to swallow
40-60	Give 6 oz. OJ, non-fat milk, or regular soda	Give 50 ml of D50W IV push <b>STAT</b> and notify MD
Less than 40	Give 25 ml of D50W IV push <b>STAT</b> and notify MD	

Check fingerstick glucose q 10-15 minutes and follow hospital hypoglycemia protocol until BG is greater than 100 mg/dL  
Notify MD if hypoglycemia persists beyond 30 minutes

- 7.  **CONSULT:** Diabetes nurse educator & Nutritionist
- 8.  **NURSING EDUCATION:** Allow/instruct patient to self administer insulin

\_\_\_\_\_  
Nurse's Signature

\_\_\_\_\_  
Signature of Physician

\_\_\_\_\_  
Name (Print)

\_\_\_\_\_  
MSID#

\_\_\_\_\_  
Pager #

\_\_\_\_\_  
Date/Time



# Basal Bolus Insulin Regimen: Summary

---

- D/C oral antidiabetic drugs on admission
- Starting total daily dose (TDD):
  - 0.3 U/kg/d in elderly and renal failure (lean?)
  - 0.4 U/kg/d x BG between 140-200 mg/dL
  - 0.5 U/kg/d x BG between 201-400 mg/dL
- Half of TDD as insulin glargine and half as rapid-acting insulin (lispro, aspart, glulisine)
- Decrease outpatient insulin dose by 20-25%

Umpierrez et al, Diabetes Care 2007; JCEM 2009; Diabetes Care 2011

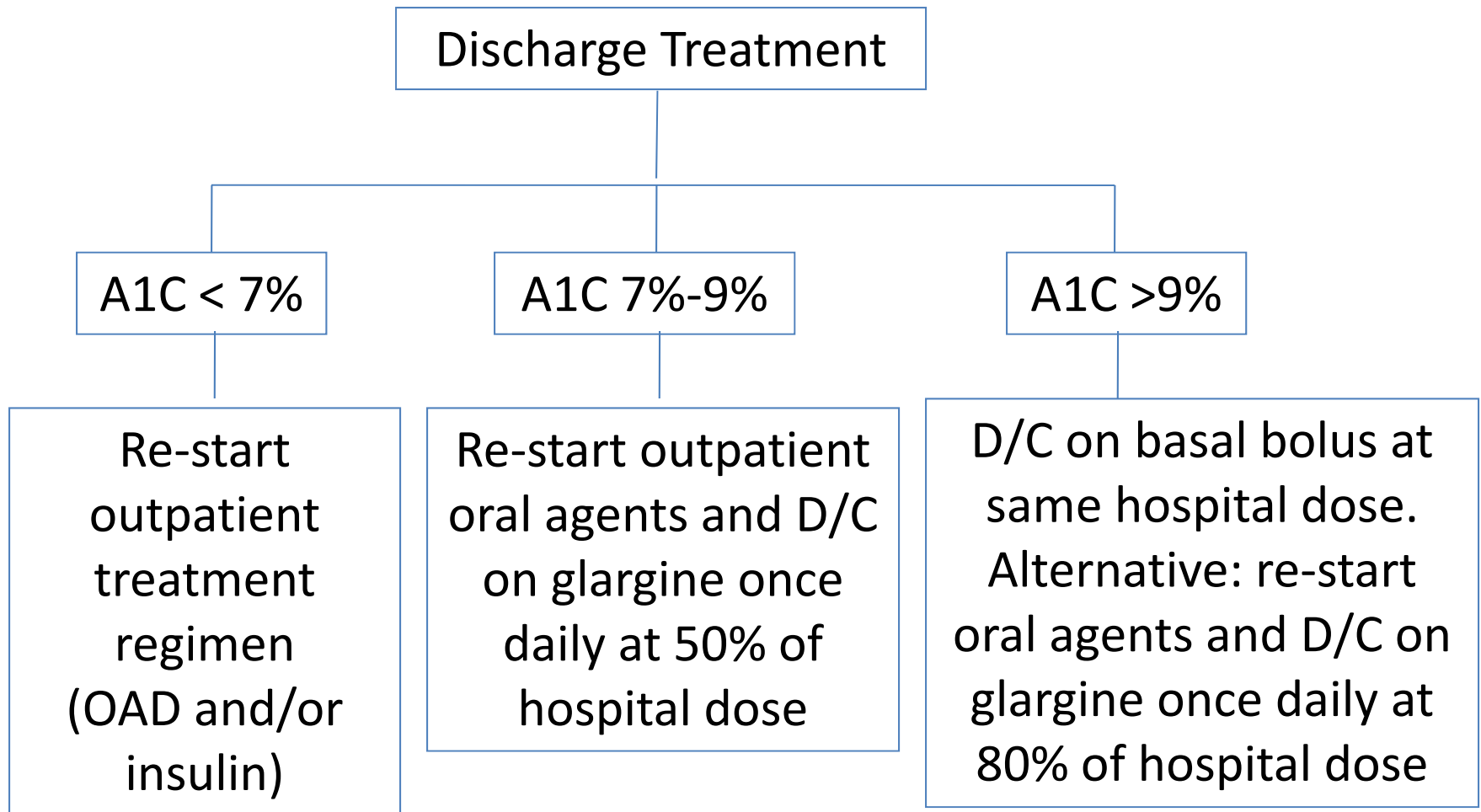
# Basal Bolus: Insulin Dose Adjustment

---

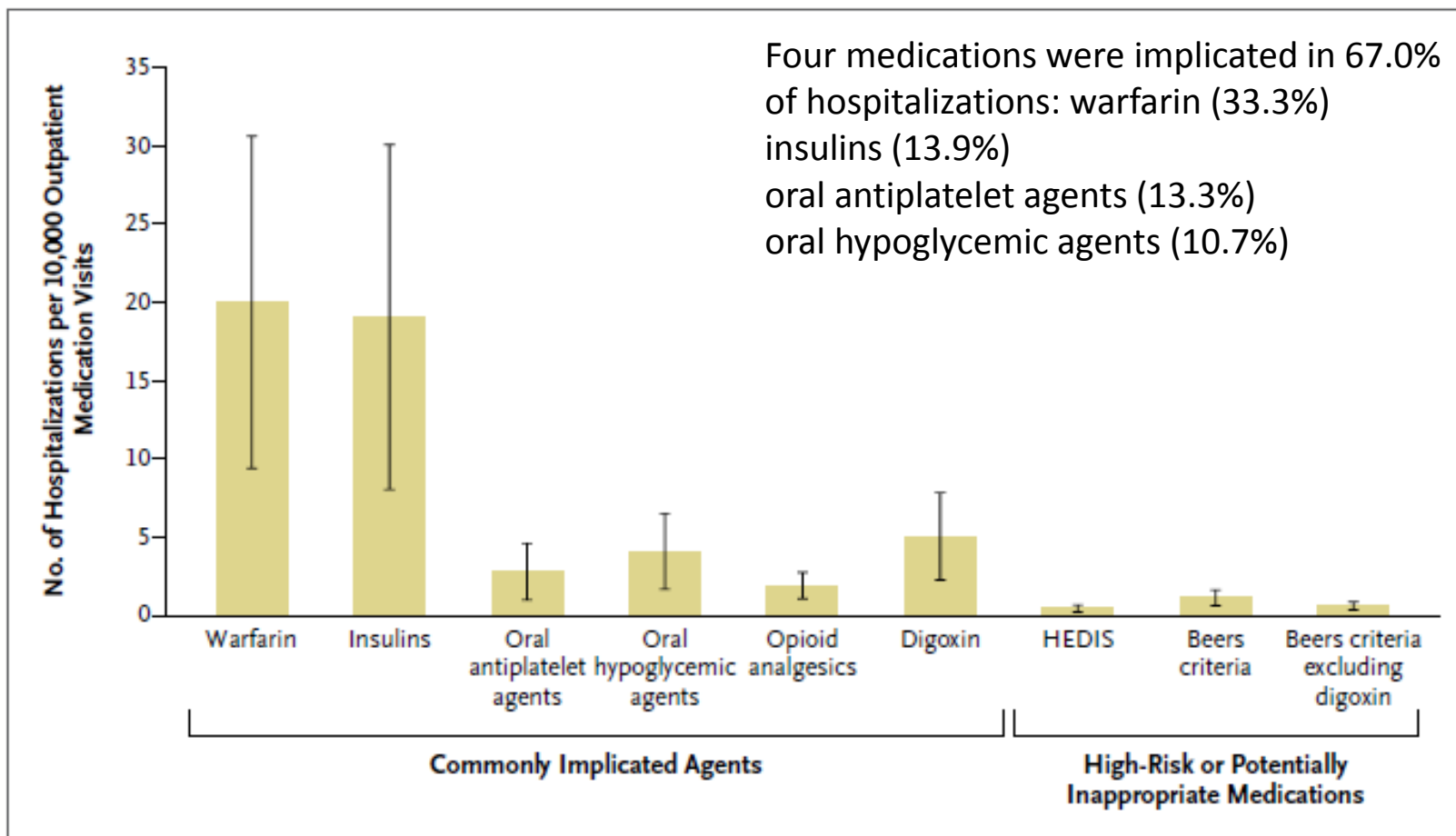
Blood glucose levels	Change in Daily Insulin Dose*
Fasting and pre-meal BG between 100-140 mg/dl in the absence of hypoglycemia	no change
Fasting and pre-meal BG between 141-180 mg/dl in the absence of hypoglycemia	Increase by 10%
Fasting and pre-meal BG between >181 mg/dl in the absence of hypoglycemia	Increase by 20%
Fasting and pre-meal BG between 70-99 mg/dl in the absence of hypoglycemia	Decrease by 10%
Fasting and pre-meal BG between <70 mg/dl	Decrease by 20%

# Emory Discharge insulin Algorithm

---



# Estimated Rates of Emergency Hospitalizations for Adverse Drug Events in Older U.S. Adults, 2007–2009



# Discharge Medications

- Supplies:
  - Meter, strips, lancets
  - Pens + Pen needles [300 units/pen]
  - Vials + Syringes [1000 units/vial]
- There is a significant difference in cost in insulins. Check with patient/insurance.

# Insulins

- Short acting
  - Regular (\$25/vial)
  - Aspart (Fiasp\*)
  - Lispro
  - Glulisine
  - Inhaled insulin
- Combinations
  - 70/30 (\$25/vial), 75/25
- Intermediate/Long
  - NPH (\$25 vial)
  - Detemir
  - Glargine (100/300)
  - Degludec (100/200)
  - U500 Regular
- Combinations
  - GLP-1 + Insulin

# Diabetes Medications Type 2

- Insulin Secretagogues
  - Sulfonylureas
  - Non-sulfonylureas
- Incretins
  - GLP-1 agonists
    - Exenatide
    - Liraglutide
    - Extended release Exenatide
    - Dulaglutide
    - Albiglutide
  - Sitagliptin
  - Saxagliptin
  - Vildagliptin
  - Alogliptin
  - Linagliptin
- Metformin
- TZD's
  - *Rosiglitazone\**
  - Pioglitazone
- Alpha glucosidase inhibitors
  - Acarbose
  - Miglitol
- Colesevelam
- Bromocryptine QR
- Pramlintide
- *Sodium-glucose cotransporter 2 (SGLT2) inhibitors (gliflozins)\**
  - *Canagliflozin*
  - *Dapagliflozin*
  - *Empagliflozin*

# Profiles of Antidiabetic Medications



	MET	GLP-1 RA	SGLT-2i	DPP-4i	AGi	TZD (moderate dose)	SU GLN	COLSVL	BCR-QR	INSULIN	PRAML
<b>HYPO</b>	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Moderate/ Severe Mild	Neutral	Neutral	Moderate to Severe	Neutral
<b>WEIGHT</b>	Slight Loss	Loss	Loss	Neutral	Neutral	Gain	Gain	Neutral	Neutral	Gain	Loss
<b>RENAL / GU</b>	Contra- indicated if eGFR < 30 mL/min/ 1.73 m <sup>2</sup>	Exenatide Not Indicated CrCl < 30	Not Indicated for eGFR < 45 mL/ min/1.73 m <sup>2</sup> Genital Mycotic Infections	Dose Adjustment Necessary (Except Linagliptin)  Effective in Reducing Albuminuria	Neutral	Neutral	More Hypo Risk	Neutral	Neutral	More Hypo Risk	Neutral
		Possible Benefit of Liraglutide	Possible Benefit of Empagliflozin								
<b>GI Sx</b>	Moderate	Moderate	Neutral	Neutral	Moderate	Neutral	Neutral	Mild	Moderate	Neutral	Moderate
<b>CHF CARDIAC ASCVD</b>	Neutral	See #1	See #2	See #3	Neutral	Moderate	Neutral	Neutral	Neutral	CHF Risk	Neutral
						May Reduce Stroke Risk	Possible ASCVD Risk	Benefit	Safe		
<b>BONE</b>	Neutral	Neutral	Mild Fracture Risk	Neutral	Neutral	Moderate Fracture Risk	Neutral	Neutral	Neutral	Neutral	Neutral
<b>KETOACIDOSIS</b>	Neutral	Neutral	DKA Can Occur in Various Stress Settings	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral

■ Few adverse events or possible benefits   
 ■ Likelihood of adverse effects  
■ Use with caution

1. Liraglutide—FDA approved for prevention of MACE events.
2. Empagliflozin—FDA approved to reduce CV mortality. Canagliflozin shown to reduce MACE events.
3. Possible increased hospitalizations for heart failure with alogliptin and saxagliptin.



# Insulin Pumps

This is a fully functioning hybrid pump



SmartGuard™ features:

## **AUTO MODE<sup>2</sup>**

- Automatically adjusts your basal (background) insulin every five minutes based on your CGM readings.<sup>2,4</sup>
- Helps keep your sugar levels in your target range for fewer lows and highs — day and night.<sup>2,4,1</sup>

▶ [See how Auto Mode works](#)

## **SUSPEND BEFORE LOW<sup>5</sup>**

- Stops insulin up to 30 minutes before reaching your preset low limits.
- Automatically restarts insulin when your levels recover without bothersome alerts.<sup>6</sup>
- Helps you avoid lows and rebound highs.<sup>1</sup>

This is not



# Sharing CGMS data



***The AACE/ACE Comprehensive Type 2 Diabetes Management Algorithm can be found by using the QR code below:***



# Prevention

- Use MPP's in EMR – includes hypoglycemic protocol
- DM Nurse Educator/Nutritionist
- DKA Case Managers & Virtual f/u (@ MHH)
  - Laura McKinney/Cynthia Lew
  - Arrange for f/u and education
  - Myhealth Advocate
- Endocrinology consult (All insulin pumps)