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 ⇒ ↑FFA

• Liver;
  ↓Insulin / ↑Glucagon ⇒ ↑Ketones
Stress/Infection → Catecholamines → Volume contraction → Hyperglycemia → Absolute/Relative ↓ Insulin → Ketogenesis → Stress/Infection

- ER Labs; Glucose 900 mg/dl
- β-OHB; 4.5 mmol/L
- pH 7.20 pCO₂ 20, pO₂ 105
- Na+ 125, K+ 4.5, Cl 90, HCO₃ 12, Cr 1.5, BUN 40
- Ca++ 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

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

Fig. 2 – Differential diagnosis of DKA. Data adapted from ref [19].
<table>
<thead>
<tr>
<th>Test</th>
<th>Starvation or high fat intake</th>
<th>DKA</th>
<th>Lactic acidosis</th>
<th>Uremic acidosis</th>
<th>Alcoholic ketosis (starvation)</th>
<th>Salicylate intoxication</th>
<th>Methanol or ethylene glycol intoxication</th>
<th>Hyperosmolar coma</th>
<th>Hypoglycemic coma</th>
<th>Rhabdomyolysis</th>
<th>Isoproproly alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Normal</td>
<td>↓</td>
<td>↓</td>
<td>Normal</td>
<td>Normal</td>
<td>↓</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
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<td>Normal</td>
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<tr>
<td>Plasma glucose</td>
<td>Normal</td>
<td>↑</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal or ↓</td>
<td>↓</td>
<td>Normal or ↓</td>
<td>Normal</td>
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<td>Negative</td>
<td>Negative</td>
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<tr>
<td>Glycosuria</td>
<td>Negative</td>
<td>++</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative†</td>
<td>↑</td>
<td>Normal or ↓</td>
<td>Normal</td>
<td>Normal</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Total plasma ketones*</td>
<td>Slight ↑</td>
<td>↑</td>
<td>↑</td>
<td>Normal</td>
<td>Normal</td>
<td>↑</td>
<td>Normal or slight ↑</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>↑</td>
</tr>
<tr>
<td>Anion gap</td>
<td>Slight ↑</td>
<td>↑</td>
<td>↑</td>
<td>Slight ↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>↑</td>
</tr>
<tr>
<td>Osmolality</td>
<td>Normal</td>
<td>↑</td>
<td>↑</td>
<td>Normal</td>
<td>Normal</td>
<td>↑</td>
<td>↑ or slight ↑</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>↑</td>
</tr>
<tr>
<td>Uric Acid</td>
<td>Mild (starvation)</td>
<td>↑</td>
<td>↑</td>
<td>Normal</td>
<td>Normal</td>
<td>↑</td>
<td>↑ or slight ↑</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>↑</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>False-positive</td>
<td>May give lactate for ethylene glycol</td>
<td>Serum &gt; 200 &gt;7 mmol/l</td>
<td>BUN mg/dl</td>
<td>Salicylate</td>
<td>Serum levels positive</td>
<td>Serum positive</td>
<td>hemoglobinuria</td>
<td>Myoglobinuria</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: ↑ indicates increased, ↓ indicates decreased, and † indicates slight to moderate decrease. Values in italics represent typical or expected findings.
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 = (Na + K) - (bicarb + chloride).
  Abnormal > 12. [abnormal > 10 if K+ not included]
• Osmolar gap. Measured osmoles – calculated osmoles.
• Calculated osmoles = 2(Na) + K + \( \frac{\text{BUN}}{2.8} \) + (glu/18)
• Corrected Na = Measured Na + {1.6 x [glu -100]/100}.
• Arterial pH = 6.97 + (0.0163 x 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 measure Na is in the normal range without correction in the setting of significant hyperglycemia, this is likely due to loss free H2O.
• Note: Pseudohyponatremia due to chylomicronemia
Characterization of Diabetes

• Beta cell reserve: “β-”
  – 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.
  – 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 1st 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 1st 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>
<thead>
<tr>
<th>Serum Potassium (mEq/L)</th>
<th>Repletion</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;5.3</td>
<td>No repletion, repeat in 1 h.</td>
</tr>
<tr>
<td>4.0–5.3</td>
<td>Add 10 mEq/L KCl/h to IV fluids.</td>
</tr>
<tr>
<td>3.5–&lt;4.0</td>
<td>Add 20 mEq/L KCl/h to IV fluids.</td>
</tr>
<tr>
<td>&lt;3.5</td>
<td>Hold insulin. Add 20–60 mEq/L/h to IV fluids, place on continuous cardiac monitor.</td>
</tr>
</tbody>
</table>

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.
  – Serium osm < 320, give 2-3L bolus of NS in 1\textsuperscript{st} hr. (rather than 1-2L)
  – If serum osm > 320, some suggest:
    • Give 1.5L hypotonic saline for 1\textsuperscript{st} hr.
    • 1 L of hypotonic saline for 2\textsuperscript{nd} and 3\textsuperscript{rd} hrs.
    • 500-750 cc of hypotonic saline for 4\textsuperscript{th} 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 exacerbation 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+ 155, K+ 3.9, Cl 105, HCO₃ 15, AG
- Cr 1.1, BUN 26
- Ca++ 8.5, Phos 2.5, Albumin 4
12 hours after admission

- Glucose 350 mg/dl
- ↓Serum ketones
- Na+ 155, K+ 3.0, Cl 115, HCO₃ 12, AG
- Cr 1.1, BUN 26
- Ca++ 8.0, Phos 2.0
18 hours after admission

- Glucose 200 mg/dl
- ↓Serum ketones
- Na+ 148, K+ 3.0, Cl 120, HCO₃ 12, AG
- Cr 0.9, BUN 18
- Ca++ 8.0, Phos 2.0
24 hours after admission

- Glucose 200 mg/dl
- Neg Serum ketones
- Na+ 140, K+ 3.4, Cl 115, HCO₃ 15, AG
- Cr 0.6, BUN 10
- Ca++ 8.0, Phos 2.0
- Hungry, clinically improved
Insulin Infusion Orders for ICU MPP
Insulin Management of Diabetes Pre-operative Orders MPP
Insulin Sub-Q Orders for Patients on Oral Nutrition MPP
Insulin Sub-Q Orders for Patients on Parenteral/Enteral Nutrition MPP
Insulin TRANSITION IV to Sub-Q for ICU Patients on Oral Supplementation
Insulin TRANSITION IV to Sub-Q for ICU Patients on Parenteral/Enteral Nutrition MPP
Insulin-like Growth Factor I
Insulin-like Growth Factor II
Insulin (R) 100 unit in NS 100 ml (DKA titrate) IV
Insulin (R) 100 unit in NS 100ml (ICU Titrate) IV
Insulin (R) 100 unit in NS 100ml (Titrage) IV
Insulin Antibody
insulin aspart
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

Insulin Level
insulin lispro
insulin lispro-insulin lispro protamine 25/75
insulin lispro-insulin lispro protamine 50/50
Insulin regular
Insulin Regular (1 unit/ml) Pediatric DKA >10 kg
Insulin Regular (1 unit/ml) Pediatric DKA <10 kg
insulin regular 100 units/mL human recombinant
insulin regular human recombinant 500 units/mL injectable sol...
Insulin regular PICU (0.5 units/mL) < 10 kg
Insulin regular PICU (1 unit/mL) > 10 kg
Insulin Timed Study
Insulinoma Antigen 2
**MHH – Atlanta protocol**

**Insulin Infusion Orders for ICU MPP (Planned Pending)**

<table>
<thead>
<tr>
<th>Component</th>
<th>Status</th>
<th>Duration</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laboratory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point of Care Blood Glucose AC4</td>
<td></td>
<td>T: N, Routine, Q1H</td>
<td>Use whole blood (NOT fingerstick sample) when a patient is on vasopressor (epinephrine, isoproterenol, phen...</td>
</tr>
<tr>
<td>Potassium Level</td>
<td></td>
<td>T: N, Timed Study, Q8H, 48, hr</td>
<td></td>
</tr>
<tr>
<td><strong>Medications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consider Endocrinology consult if patient has frequent episodes of hypoglycemia (FBG &lt;= 60 mg/dl), hyperglycemia (FBG &gt; = 200 mg/dl), or HAIc &gt;= 8.5 %.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICU INSULIN INFUSION FOR CRITICALLY ILL PATIENTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em><strong>NOT FOR PATIENTS WITH DIABETIC KETOACIDOSIS OR HYPERGLYCEMIC HYPEROSMOLAR STATE</strong></em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD to Nurse Order, Misc</td>
<td>LOW Target= 110 mg/dl, and High Target= 180mg/dl.</td>
<td></td>
<td>Do Not Start Insulin Drip Unless Potassium is More Than 3.3 mEq/L.</td>
</tr>
<tr>
<td>MD to Nurse Order, Misc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin (R) 100 unit in NS 100ml (ICU Titrate) IV</td>
<td>99 ml, Rate: Start Insulin Drip Per ICU Protocol, kg, Route: IVPB, Replace Every: 24 hr</td>
<td>Use Atlanta Insulin Infusion Protocol on the Clinical Calculator. Initial Insulin Drip Rate (units/hour)=(Fasting Blood Glucose-60)/0.03 “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. <strong>For ICU Use Only</strong></td>
<td></td>
</tr>
<tr>
<td>MD to Nurse Order, Misc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dextrose 50% in Water IV (Dextrose 50% Syringe)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dextrose 50% in Water IV (Dextrose 50% Syringe)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Notify MD</td>
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<td>Notify MD</td>
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<tr>
<td>Notify MD</td>
<td></td>
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</tr>
</tbody>
</table>

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**Note:** The image contains a screenshot of a software interface with a list of insulin infusion orders and protocols. The text highlights specific instructions and considerations for insulin management in critically ill patients, emphasizing the critical nature of monitoring and adjusting insulin therapy based on blood glucose levels.
MHH – DKA protocol

Loading Dose:
- Insulin regular
- Maintenance Dose:
  - DO NOT uncheck the Insulin Infusion order from this MPP when transitioning from the ED to Inpatient DKA Orders
  - Insulin (R) 100 unit in NS 100ml (Titrate) IV
  - Insulin to Nurse Order, Misc
  - Dextrose 50% in Water IV (Dextrose 50% Syringe)
  - Dextrose 50% in Water IV (Dextrose 50% Syringe)
  - glucagon
- glucagon
- DKA Electrolyte Replacement MPP
- Planned Pen...
- Patient Care (MD to Nurse)
  - MD to Nurse Order, Misc
  - MD to Nurse Order, Misc
  - MD to Nurse Order, Misc
  - Notify MD
  - Patient Education AC4
  - Diabetes Nurse Educator Consult - Adult
- Non Categorized
  - CDK DKA Orders

Details

<table>
<thead>
<tr>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Details</td>
</tr>
</tbody>
</table>

Do Table
Save as My Favorite

0.1 unit/kg, Route: IV, ONCE, Priority: STAT

99 mL, Rate: Titrate, kg, Route: IV, Priority: Routine, Replace Every: 24 hr
Start insulin infusion 0.1 unit/kg/hr X ___ kg = ___ units/hr
(If NO LOADING DOSE IS GIVEN: Start...

Insulin (R) 100 unit in NS 100ml (Titrate) IV

Details:
99 mL, Rate: Titrate, kg, Route: IV, Priority: Routine, Replace Every: 24 hr
Order Comment:
Start insulin infusion 0.1 unit/kg/hr X ___ kg = ___ units/hr
(If NO LOADING DOSE IS GIVEN: Start insulin infusion at 0.14 unit/kg/hr X ___ kg = ___ units/hr)

STEP 1: Utilize when BG > 250 mg/dl and patient is on NS.
Check BG fingerstick hourly after start of infusion (if BG < 250 mg/dl, skip to STEP 2).
Once reach Step 2, do not go back to Step 1 regardless of BG.

**If finger stick BG > 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 >= 20 units/hr*

If BG decreases by < 50 mg/dl OR Increases, double the insulin infusion rate to a Max rate of 20 units/hr.
Contact MD if new rate is > 20 units/hr and/or if BG increases by > 150 mg/dl.
If BG decreases by 50-100 mg/dl, NO CHANGE in Infusion Rate.
If BG decreases by > 100 mg/dl and BG > 400, continue infusion rate.
If BG decreases by > 100 mg/dl and BG > 400, notify MD.

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 DSW/NS), continue checking BG fingerstick hourly.
*Contact MD if BG > 400 or insulin rate is >= 20 units/hr*

If finger stick BG is > 400, RN must confirm BG with blood draw
If BG < 80, contact MD and hold insulin drip, check finger stick BG every 15 minutes after infusion stopped. Restart insulin drip after finger stick BG > 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...*
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>PrefList</th>
<th>Code</th>
<th>Dos</th>
<th>Route</th>
<th>Frequent</th>
</tr>
</thead>
<tbody>
<tr>
<td>**ADULT INSULIN <strong>OPEN ORDERSET</strong></td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin NPH (Humulin N) injection</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin NPH regular (NovoLIN 70-30) injection</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin asp prot-insulin asp (NovoLOG MIX 70/30 FLEXPEN) pen</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
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<td></td>
</tr>
<tr>
<td>insulin aspart (NovoLOG FLEXPEN) pen</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin aspart (NovoLOG) injection</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin detemir (LEVEMIR FLEXPEN) pen</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin detemir (LEVEMIR) injection</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin glargine (LANTUS) injection</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin lispro (Humalog) injection</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulin regular (Humulin R) Injection</td>
<td>Medicatic</td>
<td>HCHD IP AD</td>
<td>Lab</td>
<td>IP CPOE LAI INSC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please select appropriate order set for the patient to proceed.

- Open Order Set: Adult Insulin Drip/Infusion Orders
- Open Order Set: Adult Subcutaneous Insulin Orders
- Open Order Set: Adult DKA and HHS Insulin Orders
- Open Order Set: Adult OB/Gyn Insulin orders
### LBJ – insulin DKA

For blood glucose > 200 mg/dL or > 500 mg/dL IN THE URGENT CARE CENTER and Dextrose to TR (select appropriate order below)

For blood glucose < 100 mg/dL, consider using Dextrose 10% + 0.9% NaCl order below.

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

#### 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](http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/DKA_HHS_Nursing Guidelines.pdf)

- **Give one-time dose of specified Regular Insulin IV push prior to initiating insulin infusion (suggest 0.1 unit/kg)**
- **Start hourly infusion of Regular Insulin at specified rate (suggest 0.1 unit/kg/hr)**
- **Insulin REGULAR bolus if blood glucose does not decrease by 75 mg/dL in one hour**
- **If BG does not decrease by 75 mg/dL in any hour, give bolus Regular insulin with no rate change**

#### 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.

<table>
<thead>
<tr>
<th>Order</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>If potassium &lt;= 3.3 mEq/L give KCl as needed (limit 10 mEq per hour</td>
<td>10 mEq, Intravenous, PRN For 30 Days,</td>
</tr>
<tr>
<td>peripherally)</td>
<td>Other, See administration instruction,</td>
</tr>
<tr>
<td>If potassium is 3.3 to 5.3 mEq/L give KCl as needed (limit 10 mEq</td>
<td>Routine</td>
</tr>
<tr>
<td>per hour peripherally)</td>
<td></td>
</tr>
<tr>
<td>Potassium &gt; 5.3 mEq/L: recheck potassium in 2 hours and change all</td>
<td>Routine, UNTIL DISCONTINUED, Starting</td>
</tr>
<tr>
<td>IVs to solutions without KCl added</td>
<td>today, DKA/HHS Protocol: If Potassium &gt;</td>
</tr>
<tr>
<td>potassium chloride (KLOR-CON) 20 mEq oral packet</td>
<td>5.3 mEq/L: recheck potassium in 2 hours</td>
</tr>
<tr>
<td></td>
<td>and change all IVs to solutions without</td>
</tr>
<tr>
<td></td>
<td>KCl added</td>
</tr>
</tbody>
</table>

#### Medications

[Hypoglycemia Medication Orders](http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Hypoglycemia)

[Hypoglycemia Management Protocol](http://hhintranet02/departments/pharmacydept/epic/smartsets/guidance/Hypoglycemia)
# LBJ – insulin gtt

## General

### Notify Physician
- 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.
- 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

### POCT Glucose
- POCT Glucose
  - Routine, 1 TIME, Starting today, between 15 and 30 minutes after treatment of hypoglycemia.
- 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.
- POCT Glucose
  - Routine, EVERY 1 HOUR, Starting today, if blood glucose is above target.

## Labs

### Common Labs
- 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
- **Insulin (regular human 100 Units in 0.9% NaCl 100 mL IV drip)**
  - Intravenous, TITRATABLE-SEE ADMIN INSTR: Starting today For 30 Days, Routine
- If TPN interrupted, immediately start **10% Dextrose in 0.45 % NaCl @ 100 mEq/L/hr**, Intravenous, AS DIRECTED, Routine
- If TPN interrupted, immediately start **10% Dextrose in 0.225 % NaCl @ 100 mEq/L/hr**, Intravenous, AS DIRECTED, Routine

### Hypoglycemia Management Orders
- [Hypoglycemia Management Protocol](http://nhintranet02/departments/pharmacydept/epic/smartsets/guidance/hypoglycemia_Management.pdf)
- **Dextrose 50 % injection**
  - IV Push, PRN For 30 Days, Other, See Admin Instruction, Routine
Mild DKA Pilot

<table>
<thead>
<tr>
<th>Eligibility Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Blood glucose &gt; 250 mg/dL</td>
<td>1. Age ≥ 80 years</td>
</tr>
<tr>
<td>2. pH &gt; 7.25</td>
<td>2. Altered Mental Status</td>
</tr>
<tr>
<td>3. HCO3 &gt; 15</td>
<td>3. Acute Myocardial Infarction</td>
</tr>
<tr>
<td>4. BOHB or serum ketones &lt; 3</td>
<td>4. Congestive Heart Failure (NYHA Class III or IV)</td>
</tr>
<tr>
<td></td>
<td>5. Pregnancy</td>
</tr>
<tr>
<td></td>
<td>6. EGFR &lt; 45 ml/min</td>
</tr>
<tr>
<td></td>
<td>7. MAP &lt; 65</td>
</tr>
<tr>
<td></td>
<td>8. Severe Pancreatitis</td>
</tr>
<tr>
<td></td>
<td>9. Anasarca</td>
</tr>
</tbody>
</table>

Insulin Aspart/Lispro

<table>
<thead>
<tr>
<th>Initial Bolus</th>
<th>0.3 units/kg SC x 1 dose (max dose of 30 units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood glucose ≥ 250 mg/dL</td>
<td>0.2 units/kg SC every 2 hours (max dose of 20 units)</td>
</tr>
<tr>
<td>Blood glucose is &lt; 250 mg/dL</td>
<td>0.1 units/kg SC every 2 hours (max dose of 10 units)</td>
</tr>
</tbody>
</table>
• 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 PO

<table>
<thead>
<tr>
<th>Component</th>
<th>Status</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD to Nurse Order, Misc</td>
<td></td>
<td>Discontinue all previous insulin orders.</td>
</tr>
<tr>
<td>Point of Care Blood Glucose AC4</td>
<td></td>
<td>TPN, Routine, Before Meals &amp; Bedtime</td>
</tr>
<tr>
<td>Notify MD</td>
<td></td>
<td>Notify MD if blood glucose &gt; 300 mg/dl or &lt; 60 mg/dl.</td>
</tr>
<tr>
<td><em><strong>SCHEDULED BASAL INSULIN (Please select one)</strong></em></td>
<td></td>
<td>Notify MD if patient becomes NPO or if parenteral/enteral nutrition is stopped (review insulin orders).</td>
</tr>
<tr>
<td>Insulin glargine</td>
<td></td>
<td>Recommended for Fasting Blood Glucose greater than 180 mg/dl. Start with 0.2 units/kg (MAX 30 to 40 units) Sub-Q daily dose.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If pre-meal glucose is persistently above target, consider Increasing Basal dose by 20%.</td>
</tr>
<tr>
<td>Insulin isophane (Insulin isophane-NPH)</td>
<td></td>
<td>Unit, Route: SUB-Q, Q12H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check with prescriber prior to holding the dose.</td>
</tr>
<tr>
<td>Insulin detemir</td>
<td></td>
<td>Unit, Route: SUB-Q, Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check with prescriber prior to holding the dose.</td>
</tr>
<tr>
<td><em><strong>SCHEDULED Pre Meal INSULIN</strong></em></td>
<td></td>
<td>Start with 0.05 units/kg (MAX 10 units) before meals</td>
</tr>
<tr>
<td>Insulin aspart</td>
<td></td>
<td>Unit, Route: SUB-Q, TID-Before Meals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Before Breakfast, Lunch and Dinner ONLY. If pre-lunch and bedtime glucose is persistently above target...</td>
</tr>
<tr>
<td>Insulin regular</td>
<td></td>
<td>Unit, Route: SUB-Q, TID-Before Meals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Before Breakfast, Lunch and Dinner ONLY</td>
</tr>
<tr>
<td><em><strong>INSULIN CORRECTION DOSES</strong></em></td>
<td></td>
<td>Please select a Starting, Medium or High Correction Dose regimen and consider a bedtime Correction Dose regimen in addition</td>
</tr>
<tr>
<td>Aspart (Novolog) Starting Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspart (Novolog) Medium Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspart (Novolog) High Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspart (Novolog) Bedtime Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do NOT order Regular Insulin Correction dose along with Aspart pre-meal or Aspart correction doses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular Insulin Starting Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular Insulin Medium Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular Insulin High Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular Insulin Bedtime Correction Doses MPP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MHH – when NPO/TFs

<table>
<thead>
<tr>
<th>Component</th>
<th>Status</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin Sub-Q Orders for Patients on Parenteral/Enteral Nutrition or NPO MPP (Planned Pending)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Medications

- Do NOT use for patients being converted from Insulin drips
- MD to Nurse Order, Misc
  - Discontinue all previous insulin orders.
- Point of Care Blood Glucose AC4
  - T;N, Routine, Q6H
- Notify MD
  - Notify MD for blood glucose > 300mg/dl or < 60 mg/dl.
- 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 HbA1c 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%
  - insulin detemir
    - unit, Route: SUB-Q, Daily
    - Do not hold insulin without contacting the prescriber.
- insulin glargine
  - unit, Route: SUB-Q, Daily
  - Do not hold insulin without contacting the prescriber.
- insulin isophane (insulin isophane-NPH)
  - unit, Route: SUB-Q, Q8H
  - Do not hold insulin without contacting the prescriber.

**INSULIN CORRECTION DOES**
- Aspart (Novolog) for Parenteral/Enteral or NPO Stenting...
- Aspart (Novolog) for Parenteral/Enteral or NPO Mediation...
- Aspart (Novolog) for Parenteral/Enteral or NPO High ...
- Regular Insulin for Parenteral/Enteral or NPO Starting ...
- Regular Insulin for Parenteral/Enteral or NPO Medium ...
- Regular Insulin for Parenteral/Enteral or NPO High Cor...
### MHH – hypoglycemic protocol

<table>
<thead>
<tr>
<th>Hypoglycemia Orders***</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD to Nurse Order, Misc</td>
</tr>
</tbody>
</table>

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...

<table>
<thead>
<tr>
<th>Dextrose 50% in Water IV (Dextrose 50% Syringe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dextrose 50% in Water IV (Dextrose 50% Syringe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mL, Route: IVP, PRN, PRN Blood Glucose Results if Blood Glucose &lt; 40 mg/dL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>glucagon</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mg, Route: IM, PRN, PRN Blood Glucose Results For BG &lt; 60 mg/dL if no IV access and patient is either Unconscious, unable to swallow or npo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Care (MD to Nurse)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Education AC4</td>
</tr>
</tbody>
</table>

Daily, Instructions: Allow/instruct patient to self administer insulin.

<table>
<thead>
<tr>
<th>Notify MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of Care Blood Glucose AC4</td>
</tr>
</tbody>
</table>

q10-15min
Until Blood Glucose is > 100 mg/dL

<table>
<thead>
<tr>
<th>Consults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition Consult/Dietitian Consult (Consult Nutrition/Dietitian)</td>
</tr>
</tbody>
</table>
LBJ – insulin subq

<table>
<thead>
<tr>
<th>Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBJ – insulin subq</td>
</tr>
</tbody>
</table>

**Basal Insulin Orders**
- Please select an IV solution to reduce the risk of hypoglycemia should the tube feeding or TPN be interrupted.
- If patient is taking oral hypoglycemic agents, discontinuation should be planned.
- If patient is taking anticoagulants, please consult the pharmacist.
- If patient is taking alpha blockers, please consult the pharmacist.

**Suggested basal insulin for naive patients:**
- 0.2 units/kg per day for diabetes in 2 divided doses

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Frequency</th>
<th>Dosing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin NPH (NovoLIN N) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Daily with breakfast for 30 days, routine</td>
<td>Bedtime for 30 days, routine</td>
</tr>
<tr>
<td>Insulin glargine (LANTUS) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Every morning before breakfast for 30 days, routine</td>
<td>Every evening before dinner for 30 days, routine</td>
</tr>
<tr>
<td>Insulin 70/30 (NovoLIN) NPH and regular 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Intravenous at 100 mL/hr, as directed for 30 days, routine</td>
<td>Intravenous at 100 mL/hr, as directed for 30 days, routine</td>
</tr>
</tbody>
</table>

**Pre-meal Insulin Orders**
- Insulin should not be administered as a single injection for pre-meal insulin orders. This can be done in the Medications Activity.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Frequency</th>
<th>Dosing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin regular (Humulin R) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Routine</td>
<td>Routine</td>
</tr>
<tr>
<td>Insulin lispro (Humalog) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Routine</td>
<td>Routine</td>
</tr>
</tbody>
</table>

**Fixed Interval Insulin**
- For patients on Enteral or Parenteral Feedings.
- Insulin should not be administered as a single injection for fixed interval insulin orders. This can be done in the Medications Activity.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Frequency</th>
<th>Dosing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin NPH human (NovoLIN R) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Every 12 hours for 30 days, routine</td>
<td>Routine</td>
</tr>
<tr>
<td>Insulin regular human (NovoLIN R) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Intravenous at 100 mL/hr, as directed for 30 days, routine</td>
<td>Intravenous at 100 mL/hr, as directed for 30 days, routine</td>
</tr>
</tbody>
</table>

**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 internal PRN.
- Notify physician team before giving if patient is NPO.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Frequency</th>
<th>Dosing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin regular human (NovoLIN R) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Routine</td>
<td>Routine</td>
</tr>
<tr>
<td>Insulin lispro (Humalog) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Routine</td>
<td>Routine</td>
</tr>
</tbody>
</table>

**Correction (Supplemental) Insulin Orders BEDTIME ONLY**
- Provider should evaluate need to discontinue previous insulin correction orders. This can be done in the Medications Activity.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Frequency</th>
<th>Dosing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin regular human (NovoLIN R) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Bedtime PRN for 30 days, other, see administration instruction</td>
<td>Routine</td>
</tr>
<tr>
<td>Insulin lispro (Humalog) 100 units/mL injection</td>
<td>Subcutaneous</td>
<td>Bedtime PRN for 30 days, other, see administration instruction</td>
<td>Routine</td>
</tr>
</tbody>
</table>

**Hypoglycemia Medication Orders**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Frequency</th>
<th>Dosing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dextrose (INSTA-GLUCOSE) 40% oral gel</td>
<td>Oral</td>
<td>PRN for 30 days, other, administer per standing orders for hypoglycemia management, routine</td>
<td>Routine</td>
</tr>
<tr>
<td>Glucagon (human recombinant) (GLUCAGEN) injection</td>
<td>Intramuscular</td>
<td>PRN for 30 days, administer per standing orders for hypoglycemia management, routine</td>
<td>Routine</td>
</tr>
<tr>
<td>Dextrose 50% injection</td>
<td>IV Push</td>
<td>PRN for 30 days, administer per standing orders for hypoglycemia management, routine</td>
<td>Routine</td>
</tr>
</tbody>
</table>
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 β-OH butyrate
• Treatment: IV dextrose, thiamine ± insulin
Common Errors in Treatment of DKA

- Slow recognition (especially if glucose < 400)
- Inadequate or intermittent initial therapy
- Inadequate K+ 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?
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 SCHEITZ, M.D., PH.D., DIRK VLASSAELERS, M.D., PATRICK FERDINANDE, M.D., PH.D., PETER LAMERS, M.D., AND ROGER BOULLON, M.D., PH.D.

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 Wijngaarden, M.D., Ph.D., Herman Bobbaers, M.D., Ph.D., and Roger Bouillon, M.D., Ph.D.

Intensive versus Conventional Glucose Control in Critically Ill Patients

The NICE-SUGAR Study Investigators®
MHH – Atlanta protocol

<table>
<thead>
<tr>
<th>Component</th>
<th>Status</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td></td>
<td>T:N, Routine, Q1H Use whole blood (NOT fingerstick sample) when a patient is on vasopressor (epinephrine, isoproterenol, phen...</td>
</tr>
<tr>
<td>Potassium Level</td>
<td>T:N, Timed Study, Q8H, 48, hr</td>
<td></td>
</tr>
</tbody>
</table>

**Medications**

Consider Endocrinology consult if patient has frequent episodes of hypoglycemia (FBG < 60 mg/dl), hyperglycemia (FBG > 200 mg/dl), or HbA1c > 8.5%.

ICU INSULIN INFUSION FOR CRITICALLY ILL PATIENTS

*****NOT FOR PATIENTS WITH DIABETIC KETOACIDOSIS OR HYPERGLYCEMIC HYPEROSMOLAR STATE*****

- MD to Nurse Order, Misc
  - LOW Target= 110 mg/dl and HIGH Target= 180mg/dl.
  - Do Not Start Insulin Drip Unless Potassium is More Than 3.3 mEq/L.

- Insulin (R) 100 unit in NS 100ml (ICU Titrates) 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 Blood Glucose-60)/0.03 \text{ "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**

- Notify MD

- Notify MD

- 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
RABBIT-2 vs. DEAN Trials

Days of Insulin therapy

Blood Glucose (mg/dL)

Admit
Basal
Bolus
versus
SSRI
–non-ICU

- SSRI
- Glargine + Glulisine
- Detemir + Aspart
- NPH + Regular

Blood Glucose (mg/dL)

Days of Insulin therapy
Insulin sliding scale:

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

<table>
<thead>
<tr>
<th>BG (mg/dL)</th>
<th>Individual Dose</th>
<th>High Dose</th>
<th>Bed Time Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>units</td>
<td>3 units</td>
<td>NONE</td>
</tr>
<tr>
<td>200-249</td>
<td>units</td>
<td>6 units</td>
<td>1 unit</td>
</tr>
<tr>
<td>250-299</td>
<td>units</td>
<td>9 units</td>
<td>2 units</td>
</tr>
<tr>
<td>300-349</td>
<td>units</td>
<td>12 units</td>
<td>3 units</td>
</tr>
<tr>
<td>349 or greater</td>
<td>units</td>
<td>15 units</td>
<td>4 units</td>
</tr>
</tbody>
</table>
4. **SCHEDULED PREMEAL INSULIN**
   - 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

<table>
<thead>
<tr>
<th>BG (mg/dL)</th>
<th>Individual</th>
<th>Starting Dose</th>
<th>Medium Dose</th>
<th>High Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-199</td>
<td>units</td>
<td>1 unit</td>
<td>2 units</td>
<td>3 units</td>
</tr>
<tr>
<td>200-249</td>
<td>units</td>
<td>2 units</td>
<td>4 units</td>
<td>6 units</td>
</tr>
<tr>
<td>250-299</td>
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<td>3 units</td>
<td>6 units</td>
<td>9 units</td>
</tr>
<tr>
<td>300-349</td>
<td>units</td>
<td>4 units</td>
<td>8 units</td>
<td>12 units</td>
</tr>
<tr>
<td>349 or greater</td>
<td>units</td>
<td>5 units</td>
<td>10 units</td>
<td>15 units</td>
</tr>
<tr>
<td>Other _____</td>
<td>units</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. **HYPOGLYCEMIA (BG < 60 mg/dL)**

<table>
<thead>
<tr>
<th>BG (mg/dL)</th>
<th>AWAKE/ALERT</th>
<th>UNCONSCIOUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-60</td>
<td>Give 6 oz. OJ, non-fat milk, or regular soda</td>
<td>Give 50 ml of D50W IV push STAT and notify MD</td>
</tr>
<tr>
<td>Less than 40</td>
<td>Give 25 ml of D50W IV push STAT and notify MD</td>
<td></td>
</tr>
</tbody>
</table>

   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

<table>
<thead>
<tr>
<th>Blood glucose levels</th>
<th>Change in Daily Insulin Dose*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting and pre-meal BG between 100-140 mg/dl in the absence of hypoglycemia</td>
<td>no change</td>
</tr>
<tr>
<td>Fasting and pre-meal BG between 141-180 mg/dl in the absence of hypoglycemia</td>
<td>Increase by 10%</td>
</tr>
<tr>
<td>Fasting and pre-meal BG between &gt;181 mg/dl in the absence of hypoglycemia</td>
<td>Increase by 20%</td>
</tr>
<tr>
<td>Fasting and pre-meal BG between 70-99 mg/dl in the absence of hypoglycemia</td>
<td>Decrease by 10%</td>
</tr>
<tr>
<td>Fasting and pre-meal BG between &lt;70 mg/dl</td>
<td>Decrease by 20%</td>
</tr>
</tbody>
</table>
Emory Discharge insulin Algorithm

Discharge Treatment

- **A1C < 7%**
  - Re-start outpatient treatment regimen (OAD and/or insulin)

- **A1C 7%-9%**
  - Re-start outpatient oral agents and D/C on glargine once daily at 50% of hospital dose

- **A1C >9%**
  - D/C on basal bolus at same hospital dose.
  - Alternative: re-start oral agents and D/C on glargine once daily at 80% of hospital dose
Estimated Rates of Emergency Hospitalizations for Adverse Drug Events in Older U.S. Adults, 2007–2009

Four medications were implicated in 67.0% of hospitalizations: warfarin (33.3%), insulins (13.9%), oral antiplatelet agents (13.3%), and oral hypoglycemic agents (10.7%).

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
    - Exenetide
    - Liraglutide
    - Extended release Exenetide
    - Dulaglutide
    - Albiglutide
    - Sitagliptin
    - Saxagliptin
    - Vildagliptin
    - Alogliptin
    - Linagliptin

- **Metformin**

- **TZD’s**
  - Rosiglitazone*
  - Pioglitazone

- **Alpha glucosidase inhibitors**
  - Acarbose
  - Miglitol

- **Colestervelam**

- **Bromocryptine QR**

- **Pramlinitide**

- **Sodium-glucose cotransporter 2 (SGLT2) inhibitors (gliflozins)***
  - Canagliflozin
  - Dapagliflozin
  - Emplagliflozin
# Profiles of Antidiabetic Medications

<table>
<thead>
<tr>
<th></th>
<th>MET</th>
<th>GLP-1 RA</th>
<th>SGLT-2i</th>
<th>DPP-4i</th>
<th>AGI</th>
<th>TZD (moderate dose)</th>
<th>SU</th>
<th>COLSVL</th>
<th>BCR-QR</th>
<th>INSULIN</th>
<th>PRAML</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPO</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate/Severe</td>
<td>Mild</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate to Severe</td>
<td>Neutral</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>Slight Loss</td>
<td>Loss</td>
<td>Loss</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Gain</td>
<td>Gain</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Gain</td>
<td>Loss</td>
</tr>
<tr>
<td>RENAL / GU</td>
<td>Contraindicated if eGFR &lt; 30 mL/min/1.73 m²</td>
<td>Exenatide Not Indicated CrCl &lt; 30</td>
<td>Not Indicated for eGFR &lt; 45 mL/min/1.73 m²</td>
<td>Genital Mycotic Infections</td>
<td>Dose Adjustment Necessary (Except Linagliptin)</td>
<td>Effective in Reducing Albuminuria</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>GI Sx</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Mild</td>
<td>Moderate</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>CHF CARDIAC</td>
<td>Neutral</td>
<td>See #1</td>
<td>See #2</td>
<td>See #3</td>
<td>Neutral</td>
<td>Moderate</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>CHF Risk</td>
</tr>
<tr>
<td>ASCVD</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Mild Fracture Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate Fracture Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>BONE</td>
<td>Neutral</td>
<td>Neutral</td>
<td>DKA Can Occur in Various Stress Settings</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
</tbody>
</table>

- Green: Few adverse events or possible benefits
- Orange: Likelihood of adverse effects
- Brown: 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 albiglutin and saxagliptin.
Insulin Pumps

This is a fully functioning hybrid pump

SmartGuard™ features:

AUTO MODE
- Automatically adjusts your basal (background) insulin every five minutes based on your CGM readings. “
- Helps keep your sugar levels in your target range for fewer lows and highs — day and night.”*”
  
  See how Auto Mode works

SUSPEND BEFORE LOW
- Stops insulin up to 30 minutes before reaching your preset low limits.
- Automatically restarts insulin when your levels recover without bothersome alerts. ”
- Helps you avoid lows and rebound highs. ’

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)