

ED-ICU DKA Guideline

BACKGROUND

This document provides guidance on the medical management of patients with Diabetic Ketoacidosis (DKA) and is consistent with the approved Adult ICU DKA Order Set and PowerPlan. It also provides additional guidance specific to the EC3 environment.

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DEFINITIONS

- **DKA:** Plasma glucose >250 mg/dL; arterial pH \leq 7.30; serum $\text{HCO}_3 \leq$ 18; anion gap >10; urine/serum ketones positive; serum osmolality variable
 - Mild: pH 7.25-7.3 and serum bicarbonate between 15-18 mEq/L. Anion gap is greater than 10.
 - Moderate: pH 7.0-7.24 and serum bicarbonate 10-15 mEq/L. Anion gap is greater than 12
 - Severe: pH less than 7.0 and bicarbonate $<$ 10 mEq/L. Anion gap is greater than 12
- **HHS:** Plasma glucose >600 mg/dL; arterial pH >7.30; serum $\text{HCO}_3 >$ 15; anion gap variable; urine/serum ketones absent or “small”; effective serum osmolality >320 mOsm/kg
- **Treatment failure:** Failure to achieve any of the following within 48 hours
 - Underlying cause has not been adequately addressed
 - Anion gap \leq 12 mEq/L AND serum bicarbonate \geq 18 mEq/L x2 checks at 4 hour interval
 - Blood glucose < 200 mg/dL
 - pH > 7.3
 - Electrolytes within normal range
 - Patient is tolerating at least a full liquid diet
 - Hemodynamically stable

INCLUSION/EXCLUSION CRITERIA

- **Inclusion:**
 - Patients with mild to moderate DKA may be treated in the ED-ICU without MICU admission, as they will usually improve within 24 hours.
 - Some cases of severe DKA may also be treated in the ED-ICU at the discretion of the attending physician.
- **Exclusion:**
 - Patients with an underlying cause of DKA that would ordinarily require ICU admission by itself.
 - Severe DKA at the discretion of the attending physician.

GOALS:

- **0-12 hours**
 - Stabilize hemodynamics
 - Replete volume
 - Correct electrolytes and acid/base status
 - Search for precipitating cause
- **12-36 hours**
 - Begin/resume SQ insulin
 - Begin feeding (if patient able and glucose under control)
 - Keep BG <200 mg/dL
 - Monitor electrolytes
 - Begin/reinforce patient education

ORDER SETS

The relevant Power Plans are:

- Diabetic Ketoacidosis (DKA) Adult
- Insulin Subcutaneous Protocol Adult Subphase
- Adult Critical Care DKA Electrolyte Replacement Protocol (not currently available)

LAB MONITORING

- Q1h BG while on insulin drip
- Q4h BMP
- Initial VBG and PRN to evaluate pH
- Initial and daily CBC, Mg, and Phos
- CMP, Urinalysis, HbgA1c, and Osmolality if not checked in ED

FLUID RESUSCITATION

- Adult patients may require > 6 L in first 24 hours. Optimal rate of hydration is dependent on the clinical status of the patient.

Recommendations	
Step 1: Initial fluid resuscitation (1-2 hours)	<ul style="list-style-type: none"> • Initial fluid resuscitation with 1-2 L of NS over 1-2 hours. This will typically be completed during initial ED resuscitation* • Additional boluses during initial resuscitation as clinically indicated • Consider LR for initial fluid boluses if significantly acidotic (pH < 7.2) and more than 2L will be administered, as chloride from NS may induce hyperchloremic metabolic acidosis and worsen pH.
Step 2: Intermediate fluid resuscitation (2-4 hours)	<ul style="list-style-type: none"> • Continue fluid resuscitation with crystalloid (NS or LR) at 500 mL/hour* for next 2-4 hours, as appropriate.
Step 3: Maintenance fluids	<ul style="list-style-type: none"> • Start maintenance fluids as determined by <u>corrected</u> sodium level with either NS or 0.45% saline <ul style="list-style-type: none"> ◦ Corrected sodium = 1.6 x (glucose – 100)/100 + sodium level • If corrected sodium > 140 mmol/L → Infuse NaCl 0.45% • If corrected sodium ≤ 140 mmol/L → Infuse normal saline • If serum K is between 3.5 and 5.5, add 20 mEq KCl to each liter of fluid • Infuse at 250 – 500 mL/hr
Step 4	<ul style="list-style-type: none"> • When the first fingerstick or serum blood glucose (BG) is ≤ 250 mg/dL[§], nursing is authorized to change maintenance fluid to D5-1/2 NS and start infusion at 150 mL/hr. • When BG is 101-150, nursing is authorized to increase D5-1/2 NS by 50 mL/hr every hour until BG ≤ 150 (maximum rate of 250 mL/hr).
Step 5	<ul style="list-style-type: none"> • When fingerstick or serum BG is ≤ 150 mg/dL[§] AND insulin drip rate is < 2 units/hr, or when BG is ≤ 100 mg/dL[§] regardless of the insulin drip rate, nursing is authorized to change maintenance fluid to D10W[◊] and infuse at 150 mL/hr.
Step 6	<ul style="list-style-type: none"> • If the patient's fingerstick or serum BG is > 150 mg/dL[§] AFTER insulin infusion discontinued, nursing is authorized to discontinue IV fluids.
<p>*Use caution in patients with heart failure or renal failure. Consider POCUS echo to determine EF if unknown. [§] If both fingerstick and serum check results are available, use the lower number. [◊] Provider may order D10W-0.45%NS or D10W-NS outside the protocol if concerned for low sodium.</p>	

NURSE-DRIVEN POTASSIUM, MAGNESIUM AND PHOSPHORUS REPLACEMENT

- The Adult Critical Care DKA Electrolyte Replacement Protocol is available in PolicyTech at:
 - <https://augusta.policytech.com/dotNet/documents/?docid=972>. PowerPlan currently unavailable

SODIUM BICARBONATE REPLACEMENT

- Sodium bicarbonate replacement is not recommended if the patient's serum potassium is < 3.5 mEq/L.

Blood pH	Recommendation
< 6.9 at any point	<ul style="list-style-type: none"> • Order one dose of sodium bicarbonate 150 mEq in 1000 mL sterile water to infuse at 200 mL/hr. • Reassess pH and repeat sodium bicarbonate replacement until pH greater than 6.9.
> 6.9	Sodium bicarbonate replacement is not indicated.

NURSE-DRIVEN INITIAL INSULIN REPLACEMENT

- Do not start insulin infusion until serum potassium is > 3.3 mEq/L.

	Nursing Insulin Initiation
Step 1	Bolus (optional): If ordered by the provider, administer insulin regular human 0.1 units/kg* via IV bolus (maximum dose 12 units). Do not give repeat insulin bolus if already given in the Emergency Department.
Step 2	Infusion: Intravenous continuous infusion of insulin regular human is ordered by the provider to infuse at 0.1 unit/kg/hour* (maximum initial rate: 12 units/hr).
Step 3	Nursing to assess fingerstick BG 1 hour after initiation and every 1 hour thereafter. Nursing is authorized to titrate according to the table below.

*Use Dosing Body Weight documented in the electronic medical record.

NURSE-DRIVEN INSULIN INFUSION AND IV FLUID TITRATION

- The goal fingerstick or serum BG is 150-250 mg/dL.
- Maximum rate for nursing titration is 15 units/hr. Notify provider for rates > 15 unit/hr.

If BG is > 250 mg/dL	
Change in BG since last hourly check	Nursing Titration Instruction
Decrease by > 100 mg/dL	Decrease INSULIN rate by 2 unit/hr*
Decrease by $> 50-100$ mg/dL	Continue INSULIN at current rate
Decrease by < 50 mg/dL	Increase INSULIN rate by 1 unit/hr*
Any increase	Reassess line; if no line issue, increase INSULIN rate by 1 unit/hr*

If BG is < 250 mg/dL	
Current BG	Nursing Titration Instruction
FIRST BG > 250	Continue current INSULIN rate AND Change IV fluid to D5W-0.45%NS at 150 mL/hr (if not ordered, contact provider)
151-250 (Goal)	NO CHANGE in insulin drip rate or IV fluid
101-150	1. If current D5-1/2 NS rate is 150 mL/hr: Continue the same INSULIN rate AND increase D5-1/2 NS rate by 50 mL/hr every hour until a max of 250 mL/hr 2. If D5-1/2 NS is maxed at 250 mL/hr or D10W currently infusing: Adjust INSULIN drip following the instructions below: a. If current INSULIN drip ≥ 2 units/hr* \rightarrow Decrease INSULIN drip by 1 unit/hr* b. If current INSULIN drip < 2 units/hr* \rightarrow Continue INSULIN drip at current rate AND change IVF to D10W at 150 mL/hr or per provider order
70-100	1. Change IVF to D10W at 150 mL/hr if not already infusing a. <u>IF D10W already infusing:</u> Give additional 25 mL D50% IV every hour until BG > 100 2. AND do NOT turn off INSULIN drip. Continue to follow the INSULIN titration instructions: a. If current INSULIN drip ≥ 2 units/hr* \rightarrow Decrease INSULIN drip by 1 unit/hr* b. If current INSULIN drip < 2 units/hr* \rightarrow Continue INSULIN drip at current rate
< 70	1. Hold insulin drip and notify provider AND 2. Check BG every 15 minutes and give D50% IV per hypoglycemia protocol until BG > 70 AND 3. Resume INSULIN drip when BG > 70 at the following rate: a. Most recent BG divided by 100 (i.e., if BG is 150, resume INSULIN drip at $150/100 = 1.5$ unit/hr*)

* Do NOT confuse with unit/kg/hr. Note: Insulin 1 unit/hr = 1 mL/hr

NURSE-DRIVEN HYPOGLYCEMIA MANAGEMENT

Blood Glucose	Management	Monitoring
70-100 mg/dL	Dextrose 50% 25 mL (12 grams carbohydrates)	Give in addition to D10W IVF if D10W is already running. Check BG in 1 hour. Repeat treatment if BG remains ≤ 100 mg/dL.
51-69 mg/dL	Dextrose 50% 25 mL (12 grams carbohydrates)	Check BG in 15 minutes. Repeat treatment if BG remains < 70 mg/dL. May repeat treatment twice. If adequate response not seen, physician needs to assess patient.
31-50 mg/dL	Dextrose 50% 50 mL (25 grams carbohydrates)	

≤ 30 mg/dL	Dextrose 50% 50 mL (25 grams carbohydrates) AND 1 mg glucagon IV or IM	
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TRANSITION TO SUBCUTANEOUS INSULIN

Provider is to assess whether patient is clinically stable to be transitioned from insulin drip to subcutaneous (SQ) insulin. Insulin drip should NOT be discontinued until ALL of the following parameters are met:

- Anion gap ≤ 12 mEq/L AND serum bicarbonate ≥18 mEq/L x2
- Blood glucose < 200 mg/dL
- pH > 7.3
- Patient is tolerating at least a full liquid diet
- First basal SQ insulin (glargine) injection was administered at least 1-2 hours prior to discontinuing insulin IV infusion

If the patient meets the criteria above but is NPO, consider switching to NON-DKA insulin drip option.

If the patient meets all of the criteria above, take the following steps for transition to SQ insulin:

1. Assess patient’s home SQ insulin regimen and compliance (see table below).

	Recommendations
Previously on insulin	<ul style="list-style-type: none"> • Physician to assess compliance. • If non-compliant, resume home regimen. • If compliant, increase prior regimen by 10% or intensify prandial control.
Not previously on insulin	<ul style="list-style-type: none"> • Start basal (i.e., glargine) and pre-prandial insulin at 0.3 to 0.5 units/kg/day, 50% of dose given as basal and 50% given as pre-prandial. • May consider other options, such as insulin NPH or 70/30, if patient is unable to afford long acting insulin outpatient. NPH and 70/30, while the cheapest options for uninsured patients paying with cash, are ideally reserved for those with very consistent diets.

2. Estimate daily SQ insulin requirements by extrapolating the current insulin infusion rate to 24 hour requirement (i.e., if current rate is 2 units/hr, multiply it by 24 hours to get 48 units/day). Administer at least 50-75% of this calculated daily dose (whichever is closer to the estimated glargine dose calculated in Step 1) as basal SQ insulin for transition
3. Administer SQ insulin then turn off the drip 1-2 hours later so that there is an overlap between SQ and IV insulin.
4. Schedule daily SQ insulin regimen and add sliding scale insulin (see Adult Insulin Subcutaneous Subphase).

DISPOSITION

- Most patients treated for DKA in the EC3 should be admitted to the floor for ongoing BG monitoring, electrolyte/fluid monitoring and replacement, further adjustment of home insulin regimen as needed, and patient education.
- Some patients may be discharged home from the EC3. Discharge criteria:
 - Tolerating full diet
 - Off insulin drip for 6 hours with no rise in anion gap or drop in bicarb
 - No other condition requiring inpatient treatment
 - Has insulin at home
 - No home insulin dose adjustments are required
 - Reason for DKA is explainable and now resolved
- Some patients with resolved DKA may still require admission to the SDU based on their underlying condition.
- Patients experiencing treatment failure or deteriorating clinical status should be admitted to the ICU

REFERENCES:

- AU Health Clinical Protocol 3417 (Adult Intensive and Intermediate Care Units Diabetic Ketoacidosis (DKA) Protocol
- Adult Critical Care DKA Electrolyte Replacement Protocol is available in PolicyTech at:
 - <https://augusta.policytech.com/dotNet/documents/?docid=972>.
- Kitabchi A, Umpierrez G, Miles J, Fisher J. Hyperglycemic Crises in Adult Patients with Diabetes. Diabetes Care, 2009;32:1335-1343.