Maine Medical PARTNERS Women's Health

A department of Maine Medical Center

Diabetic Ketoacidosis in Pregnancy

Diagnosis of DKA:

- Initial STAT labs include
  - CBC with diff
  - Serum electrolytes
  - BUN
  - Creatinine
  - Glucose
  - Arterial blood gases
  - Bicarbonate
  - Urinalysis
  - Lactate
  - Serum ketones
  - Calculation of the Anion Gap
    - serum anion gap = serum sodium – (serum chloride + bicarbonate)
  - Electrocardiogram

Treatment Protocol for Diabetic Ketoacidosis

DKA/HHS Pathway Phase 1 (Adult)

DKA Diagnostic Criteria:

- Blood glucose >250 mg/dl
- Arterial pH <7.3
- Bicarbonate ≤18 mEq/l
- Anion Gap Acidosis
- Moderate ketonuria or ketonemia

1. **Start IV fluids** (1 L of 0.9% NaCl per hr initially)
2. **If serum K+ is <3.3 mEq/L hold insulin**
   - Give 40 mEq/h until K ≥ 3.3 mEq/L
3. **Initiate DKA Order Set Phase I (*In** PREGNANCY utilize OB DKA order set**)**
4. **Start insulin** 0.14 units/kg/hr IV infusion (calculate dose)
   RN will titrate per DKA protocol

***PREGNANCY**

- Utilize OB DKA order set Phase 1
- When glucose reaches 200mg/dL, Initiate OB DKA Phase 2
- Glucose goals 100-150mg/dL OB DKA Phase 2

Look for the Cause

- **Infection/Inflammation** (PNA, UTI, pancreatitis, cholecystitis)
- **Ischemia/Infarction** (myocardial, cerebral, gut)
- **Intoxication** (EtOH, drugs)
- **Iatrogenic** (drugs, lack of insulin)
- **Insulin deficiency**
- **P**regnancy

IVF

Determine hydration status

- Hypovolemic shock → Administer 0.9% naCl (1.0 L/h) and/or plasma expander
- Mild hypotension
- Cardiogenic shock → Hemo-dynamic monitoring

Evaluate corrected serum Na

- Serum Na high → 0.45% NaCl (4- 14 ml • kg^{-1} • h^{-1}) depending on hydration state
- Serum Na normal → 0.45% NaCl (4- 14 ml • kg^{-1} • h^{-1}) depending on hydration state
- Serum Na low → 0.9% NaCl (4- 14 ml • kg^{-1} • h^{-1}) depending on hydration state

Insulin

Initiate and continue insulin gtt until serum glucose reaches 250 mg/dl.
RN will titrate per protocol to achieve target.

When sugar < 250 mg/dl proceed to DKA Phase II

*In PREGNANCY when sugar <200 proceed to OB DKA Phase II

Potassium

If initial serum K^+ is <3.3 mEq/L, hold insulin and give 40 mEq K^+ per h (2/3 KCL and 1/3 $KP0_4$) until K ≥ 3.3 mEq/L

If initial serum K^+ is ≥ 5.0 mEq/L, do not give K^+ but check K^+ ever 2 h

If initial serum K^+ is ≥ 3.3 but < 5.0 mEq/L, give 20-30 mEq K^+ in each liter of IV fluid (2/3 as KCL and 1/3 as $KP0_4$) to keep serum K^+ at 4-5 mEq/L mEq/L

Bicarbonate

Assess need for bicarbonate

- pH <6.9 → Dilute $NaHCO_3$ (100 mmol) in 400 mL H_20 with 20 mEq KCL. Infuse for two hours → Repeat $NaHCO_3$ administration every two hours until pH >7.0. Monitor serum K
- pH >7.0 → No HCO_3

Approved by Diabetes Steering Committee, MMC, 2015, Revised DKA Workgroup 1_2016

DKA/HHS Pathway Phase 2 (Adult)

Phase 2: Blood sugar now less than 250mg/dL **(*BS <200mg/dL in pregnancy)**

If Anion Gap Elevated*

- Transition to **DKA Order Set Phase 2**
- Discontinue Phase 1 insulin infusion order and DKA nursing titration protocol from phase 1.
- Change to fixed dose insulin infusion at suggested rate of 2.5 units/hr (Adjust as needed for individual patient with typical dose range of 0.02 to 0.05 units/kg/hr based on drip rate and response in phase 1). Do not discontinue insulin therapy.
- Start dextrose containing IV fluid such as D5 ½ NS and adjust dextrose to goal blood sugar 150-200. (***100-150mg/dL IN PREGNANCY**)
- Continue to check labs regularly.
- Reevaluate for underlying causes and consider undetected stressors/ illness.

Follow guidelines to the right when gap has normalized.*

*Normal Anion Gap at MMC is 5-16 meq/L for the typical patient.

Approved by DKA Committee, MMC, 12/2015

If Anion Gap Normalized*

Non-ICU Patients

Desire to continue IV insulin?
- **Yes** → Change to Inpatient IV Insulin Protocol → RN will titrate Insulin using IIP calculator. → Discontinue D5 infusion if/when appropriate. → Advance diet when able/ appropriate, and if eating add prandial insulin.
- **No** → Insulin Naïve?
  - **Yes** → Consider total daily dose of 0.5 u/kg with 50% given as basal.
  - **No** → Previously Under Good Control?
    - **Yes** → Consider resuming home basal/prandial regimen.
    - **No** → Use past 6 hours of drip rate in phase 1 to estimate daily basal requirement. Reduce by 20% for safety. Order prandial insulin.

Overlap IV infusion for 2 hours with basal dose.

Order correctional insulin in addition on patients.

Advance diet as tolerated.

Critical Illness (ICU)

Change to Inpatient IV Insulin Protocol → RN will titrate Insulin using IIP calculator. → Discontinue D5 infusion if/when appropriate. → Advance diet when able/ appropriate, and if eating add prandial insulin.

Refer to Clinical Support Tools: IV Insulin or IV to SC Insulin Transition for further guidance.

Diagnostic Criteria for DKA/HHS*

	Mild	Moderate	Severe	HHS
Plasma Glucose (mg/dl)	> 250	> 250	> 250	> 600
Arterial pH	7.25 – 7.30	7.00 – 7.24	< 7.00	> 7.30
Serum Bicarbonate (meq/l)	15 to 18	10 to < 15	< 10	> 18
Urine Ketones	Positive	Positive	Positive	Small
Serum Ketones	Positive	Positive	Positive	Small
Serum Osmolarity	Variable	Variable	Variable	> 320
Anion Gap*	High Normal to Elevated	Elevated	Elevated	Variabel
Change in Mental Status	Alert	Alert/Drowsy	Stupor/Coma	Variable to Stupor/Coma

*HHS = Hyperosmolar Hyperglycemic State
*DKA = Diabetic Ketoacidosis
*Normal Anion Gap at MMC is 5-16 meq/L for the typical patient.

Approved by Glycemic Steering Committee, MMC, 2015

Additional Considerations for DKA/HHS

Diet: Patients should be kept NPO until their blood sugar is < 250mg/dl, their anion gap has normalized, and they are feeling well enough to eat. Once through the acute phase above, patients may be offered a diet and should have prandial insulin ordered as well.
Hyperglycemia: In phase 1, the desired rate of decrease is approximately 50-75 mg/dl per hour. Adjust insulin infusion based on guidelines in DKA phase 1 protocol. Additional doses of subcutaneous insulin are discouraged.
Hypernatremia: Most patients presenting with DKA will be mildly hyponatremic, but occasionally patients may present with significant *hyper*natremia. Additionally, those with HHS may frequently present with significant hypernatremia. Treatment in these patients should begin with reconstituting intravascular volume depletion with isotonic fluid such as NS or LR. Once adequately resuscitated in the acute phase, ½ NS or other hypotonic fluid should be used to address free water depletion (see phase 1 algorithm). Patients with significant hyperglycemia at presentation may experience a rise in serum sodium during treatment. That is expected and due to osmotic shifts that occur with reduction in hyperglycemia. In cases of patients presenting with significant hypernatremia initially, where serum sodium *falls* early on during treatment, there is increased concern for cerebral edema, and patients should be monitored more closely.
Hypokalemia: Insulin should be held while potassium is administered for patients with significant hypokalemia (K< 3.3 meq/l) until potassium has normalized. Patients with hypokalemia should have q1h potassium levels in early phase.

Hypophosphatemia: Body stores of phosphate are significantly depleted in DKA. Most patients with DKA, however, will not require phosphate repletion. Severe hypophosphatemia (≤1 mmol/dl) though can be a medical emergency. Patients whose phosphate falls to this level should be treated with IV phosphate repletion. Periodic measurement of phosphate levels during the initial treatment of DKA is reasonable.
Glucometers: **Use of POC glucometers is the standard of care for all inpatient settings.** In the ED and L&D, hourly venous blood glucose via DKA panel should be used as principal method of glucose measurement, and glucometers utilized only as a fail safe for concern of hypoglycemia or when venous specimen cannot be obtained. All patients in DKA/HHS should have hourly blood glucose monitoring while on an insulin infusion. As always, if POC glucose is registering >500mg/dL, hourly lab venous glucose will need to be ordered and utilized for insulin infusion titration. If any concerns exist regarding accuracy of POC testing, obtain a STAT lab venous blood glucose.
Phase 2: Once a patient's glucose has dropped to less than 250mg/dl, a patient is considered to have passed through the initial phase of treatment (Phase 1). However, patients who continue to have an elevated anion gap (>16 meq/l) due to ongoing ketoacidosis (and not another etiology) should be continued on IV insulin therapy until the anion gap has normalized. During this phase, considered Phase 2, patients should continue to have hourly blood glucose monitoring. In order to keep their sugars stable, patients should be given a dextrose infusion for a target blood sugar range of 150-200 mg/dl. The rate of dextrose and concentration of dextrose should be adjusted as needed, but most importantly is that IV insulin should not be discontinued. The exact rate of insulin infusion may be a patient specific decision based on the rates in phase 1. However, the typical dose range in Phase 2 is 0.02 to 0.05 U/kg per hour, and 2.5 units per hour is a reasonable suggested infusion rate. Once their anion gap has closed, they may be transitioned to subcutaneous insulin (with 1-2 hour overlap with the IV infusion) or continued on IV insulin titrated using the standard inpatient insulin protocol if desired.
Special Populations: Certain patients who are undernourished, or pregnant may have only mild hyperglycemia in the context of DKA, but have marked anion gap elevation from significant ketoacidosis. In these patients treatment should continue as it would normally with the focus of normalizing glucose, and continuing IV insulin until the anion gap has normalized (see phase 2 above). ***Pregnancy** requires tighter control, initiate OB DKA Phase 1 until BG 200mg/dL, then maintain BG 100-150mg/dL on IV insulin utilizing OB DKA Phase 2 until anion gap normalized.

Approved by DKA Committee, MMC, 2015

DKA and the Fetus

- After viability all patients should be monitored continuously for both fetal heart rate and contractions.
- Betamethasone and corticosteroids should be avoided.
- Fetuses exposed to maternal acidosis may show decreased variability and late decelerations. Ominous patterns will typically convert with correction of the maternal metabolic acidosis.

- Even when fetal status is questionable during the phase of therapeutic volume and plasma glucose correction, emergency cesarean section should be avoided.
- If a reasonable effort has been expended in correcting the maternal metabolic disorder and the fetal status remains a concern, delivery should not be delayed.
- For help call Medicine On-Call Doctor

Diabetic Ketoacidosis

- Diabetic ketoacidosis (DKA) in pregnancy is a medical emergency for both the mother and fetus.
- Pregnant patients with Type I diabetes are at increased risk.
- Incidence and morbidity of this complication is about 2%.
- The rate of intrauterine fetal death is about 10%.
- Precipitating factors are pulmonary, urinary or soft tissue infections, poor compliance, and unrecognized new onset of diabetes.
- Severe DKA threatens the life of both the mother and the fetus.
- Fetal well being is in jeopardy until maternal metabolic homeostasis is reestablished.
- High levels of plasma glucose and ketones are readily transported to the fetus, which may be unable to secrete sufficient quantities of insulin to prevent DKA in utero.
- DKA evolves from inadequate insulin action and functional hypoglycemia at the target tissue level. This leads to increased hepatic glucose release but decreased or absent tissue disposal of glucose.
- Glucose lacking tissues release ketone bodies, and vascular hyperglycemia promotes osmotic diuresis. The diuresis causes profound vascular volume depletion and loss of electrolytes.
- The release of stress hormones (ie. catecholemines, glucagon, growth hormone and cortisol) further impairs insulin action and contributes to insulin resistance.
- The cycle of dehydration, tissue hypoglycemia, and electrolyte depletion can lead to multisystem collapse, coma, and death.
- Early in illness, hyperglycemia and ketosis are moderate. If hyperglycemia is not corrected, diuresis, dehydration, and hyperosmolality follow. Pregnant patients in the early stages of ketoacidosis respond quickly to appropriate treatment of the initiating cause, (eg. broad-spectrum antibiotics), additional doses of regular insulin and volume replacement.
- Patients with advanced DKA usually present with typical findings:

- Hyperventilation
- Normal or obtunded mental state (depending on severity of acidosis)
- Dehydration
- Hypotension
- Fruity odor to the breath
- They may have abdominal pain, and vomiting may be prominent
- Hyperglycemia (glucose >200 mg/100mL)
- Serum ketones of 1:4 or greater