Clinical Guideline
DKA
Pediatric Emergency & Critical Care Medicine

Inclusion criteria:
• Known Diabetes Mellitus
• Concern for new onset Diabetes Mellitus
• POC Blood glucose > 200

Begin
DKA suspected?
Yes
Off algorithm, look for alternative diagnosis

No
Initiate DKA powerplan and send labs: anesthesia lab VBG with Na, K, Cl, BUN, Cr, glucose; UA, CBC, Serum Osm, HgbA1C, LFT, Mg, Phos, amylase, lipase
DO NOT DELAY TREATMENT WHILE OBTAINING LABS

Presence of shock?
Yes
Shock resolved?
No
Off algorithm, manage appropriately

No
Evidence of cerebral edema?
Yes

No
10 ml/kg NS bolus over 1 hour

DKA confirmed?
(Glucose ≥ 200 + ketonuria + bicarb <15 and/or pH <7.3)

Bicarb >15
• If initial K>6, obtain EKG
• Discuss with Endocrine
• Consider SubQ insulin

Bicarb ≤ 15
• If initial K>6, obtain EKG
• 2 bag system running at total fluids of 1.5 x maintenance rate
• Use lower initial rate if received significant bolus fluids
• Insulin drip after fluid resuscitation (remove insulin pump prior to starting infusion)
  ≤ 5 yrs: 0.05 U/kg/hr OR >5 yrs: 0.1 U/kg/hr

Never bolus insulin in DKA
• Discuss with Endocrine

Signs and symptoms of cerebral edema:
Headache
Vomiting
Inappropriate slowing of heart rate
Rising blood pressure
Decreased O2 saturation
Age inappropriate incontinence
Change in neuro status:
• Irritability
• Drowsiness
• Cranial nerve palsies
• Abnormal pupils

For questions concerning this guideline, contact:
chorclinicalguidelines@vcuhealth.org

Last updated: August 2018
Next expected update: August 2021
Clinical Guideline
DKA
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Definition of DKA:
• Blood glucose >200 mg/dl
• Ketonuria
• Serum pH <7.3 and/or bicarb <15 mmol/L

Assessment and orders:
• Use PICU DKA PowerPlan in Cerner
• Expected orders and monitoring as listed below

Initial Patient Info:  
<table>
<thead>
<tr>
<th>CHoR PICU Admission</th>
<th>Lab Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission wgt:</td>
<td>Obtain GCS score¹</td>
</tr>
<tr>
<td>Previous wgt:</td>
<td>Stabilize pt hemodynamically</td>
</tr>
<tr>
<td>Review OSH/ED Therapy</td>
<td>Start 2 bag system³</td>
</tr>
<tr>
<td>Bolus amt of IV fluid:</td>
<td>*IV rate calculation table page 2</td>
</tr>
<tr>
<td>Hourly IVF started:</td>
<td>*2-bag system titration, page 1</td>
</tr>
<tr>
<td>Insulin therapy in ED:</td>
<td>Start insulin infusion²</td>
</tr>
<tr>
<td>VS q2h, neuro check q1h</td>
<td>Routine PICU Labs</td>
</tr>
<tr>
<td>Strict I/Os</td>
<td>Q1h Glucose (on insulin drip)</td>
</tr>
<tr>
<td>NPO</td>
<td>Q1h VBG (until pH &gt;7.1)</td>
</tr>
<tr>
<td>Endocrine consult</td>
<td>Q4h BMP, mag, phos</td>
</tr>
<tr>
<td></td>
<td>Q void ketones</td>
</tr>
</tbody>
</table>

¹If GCS is less than or equal to 10, discuss need for Head CT and further management with PICU Attending

²Insulin Infusions:
• Administer continuous insulin infusion at 0.05-0.1 unit/kg/hr (start at 0.05 if ≤ age 5)
• DO NOT administer a bolus of insulin, as this may increase the risk of cerebral edema
• Insulin is used to correct patient’s acidosis by stopping ketogenesis
• During continuous insulin infusions, must check hourly blood glucose
• Goal is to decrease glucose by 50-100 mg/dL/h
• Continue insulin infusion until pH is >7.3, serum bicarbonate is >17, anion gap has normalized, and Pediatric Endocrinology agrees to transition to subcutaneous insulin
• Discuss with PICU Attending before discontinuing insulin infusion
### 3-Bag System and Insulin Titration

Total IVF rate = Bag 1 _____ ml/kg + Bag 2 _____ ml/kg

#### If K+ < 5:

<table>
<thead>
<tr>
<th>Bag 1</th>
<th>Bag 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS + KPhos 15mmol/L + KCl 20 meq/L</td>
<td>D10NS + KPhos 15mmol/L + KCl 20 meq/L</td>
</tr>
</tbody>
</table>

- Add KPhos and KCl once K+ falls <5

#### If K+ > 5:

- Bag 1: NS
- Bag 2: D10NS

### Serum glucose mg/dL

<table>
<thead>
<tr>
<th>Serum glucose</th>
<th>Insulin u/kg/hr</th>
<th>NS Bag % of IV fluids</th>
<th>Dextrose Bag % of IV fluids</th>
<th>Additional actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;300</td>
<td>0.1</td>
<td>100%</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>250-300</td>
<td>0.1</td>
<td>50%</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>200-250</td>
<td>0.1</td>
<td>25%</td>
<td></td>
<td>75%</td>
</tr>
<tr>
<td>150-200</td>
<td>0.1</td>
<td>0%</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>100-150</td>
<td>0.05-0.1</td>
<td>0%</td>
<td>100%</td>
<td>Recheck glucose in 30 minutes</td>
</tr>
</tbody>
</table>

#### < 100

- Insulin: 0.05
- Notify Attending: Order D12.5 dextrose fluid, recheck glucose q30min until >150

#### < 70

- Insulin: Off
- Notify Attending: Stop insulin infusion, if no change in mentation: give juice, if change in mentation: bolus with 2ml/kg of D25 over 5 mins, check glucose q15mins until >150 mg/dL

### Calculations:

- **Hydration Status**: The severity of DKA dehydration can be assessed using the degree of acidosis

<table>
<thead>
<tr>
<th>Hydration Status</th>
<th>Mild dehydration</th>
<th>Moderate dehydration</th>
<th>Severe dehydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>% dehydration/change in weight</td>
<td>&lt;5%</td>
<td>5-9%</td>
<td>&gt;10%</td>
</tr>
<tr>
<td>Lab values</td>
<td>pH 7.2-7.3 or Bicarb &lt;15</td>
<td>pH 7.1-7.2 or Bicarb &lt;10</td>
<td>pH &lt; 7.1 or Bicarb &lt;5</td>
</tr>
<tr>
<td>Time to rehydrate</td>
<td>36 hours</td>
<td>36-48 hours</td>
<td>48 hours or more</td>
</tr>
<tr>
<td>Fluid Bolus4</td>
<td>10 ml/kg</td>
<td>10 ml/kg</td>
<td>10-20 ml/kg</td>
</tr>
</tbody>
</table>

### IV Fluid Rate Calculation

1. Deficit = _____% dehydrated x 10 x preadmission weight in kg = _______ ml
2. Hourly maintenance rate (4-2-1 rule) x total hours to replace = _______ ml
3. Add “A” and “B” = _______ ml
4. Total fluids given by outside hospital, EMS, and VCU ED = _______ ml
5. Subtract “D” from “C” Will give you total remaining fluid to replace = _______ ml
6. Total hours remaining to infuse replacement fluids = _______ hours
7. Divide answer in “F” from “E” to obtain hourly replacement fluid rate = _______ ml/hr

(Rate will be ~1.5 maintenance fluid rate. Do not start rate above 1.5 maintenance without first discussing with PICU Attending)
Electrolyte Management:

**Sodium (Na):**
- To regulate osmolality, hyperglycemia causes fluid retention that decreases the serum Na concentration. The total body Na is normal to elevated.
- Serum Na concentration decreases by ~1.6 mmol/L for every 100 mg/dL of serum glucose above 100 mg/dL.
  - Example: If Serum Na is 127 mmol/L and serum glucose is 600 mg/dL: 600-100 = 500
  - \[ 5 \times 1.6 = 8 \]
  - Estimated corrected serum Na concentration is: 127 + 8 = 135 mEq/L
- If patient develops hypernatremia (Na >145 mmol/L) discuss IV fluid composition with PICU Attending.

**Potassium (K+):**
- With acidosis, K+ will shift from the intracellular to extracellular compartment. Once acidosis is corrected, it will shift back out into extracellular fluid.
- If K+ is < 5 mmol/L and patient is voiding, ensure sufficient K+ is added to IV fluids.
- If K+ is ≥ 5 mmol/L, DO NOT add K+ to IV fluids until patient is voiding and K+ is < 5 mmol/L.
- Subsequent potassium replacement therapy can be based on serum potassium.

**Chloride (Cl-):**
- If hyperchloremia develops (Cl- >115 mmol/L), discuss changing IV fluid with PICU Attending to 1/2 NS to decrease risk of hyperchloremic metabolic acidosis.

**Cerebral Edema:**

Signs and Symptoms can include headache, vomiting, AMS

Clinically significant cerebral edema can potentially develop within the first 4-12 hours after initiation of treatment for DKA, but may also present before treatment, or as late as 24-48 hours after treatment.

If cerebral edema is suspected:
- Administer mannitol 0.5-1.0 g/kg IV over 15 minutes.
- Effects should be noted after 15 minutes.
- Dose can be repeated after 30 minutes if needed.

Risk factors for cerebral edema:
- Initial pH <7.0
- Hypocapnia at presentation, after adjusting for acidosis
- Administration of bicarbonate
- Marked early decrease in serum osmolality
- Lower than expected rise in serum sodium concentration during therapy
- Fluid overload in first 4 hours of treatment
- Administration of insulin in the first hour of fluid treatment

**Additional Management:**

**Diet:** Keep patient NPO until acidosis is corrected and subcutaneous insulin started
- When serum bicarbonate is greater than 10 mmol/L, may consider ice chips
- Once acidosis is corrected and Pediatric Endocrine recommendations are made, order the appropriate diabetic diet
  - Give subQ insulin and diet tray
  - Stop dextrose containing IV bag and insulin gtt 30 minutes after meal
  - Can continue NS IV bag at maintenance rate until ketonuria is resolved
- Sodium Bicarbonate Use:
  - Trials have shown no clinical benefit of NaBicarb, but well recognized adverse effects noted
DKA Guideline

Executive Summary

Children’s Hospital of Richmond at VCU DKA Workgroup

Pediatric Emergency Medicine Owner: Rashida Woods, MD
Pediatric Critical Care Medicine Owner: Kathryn Pace-Davis, CPNP
Pediatric Endocrinology: Melinda Penn, MD
Pediatric Emergency Medicine: Jonathan Silverman, MD
Pediatric Emergency Medicine Nursing Practice Council (consulting): Celia Hanson, RN, CPEN

Approved (August 2018)

Pediatric Emergency Medicine Quality Committee: Rashida Woods, MD
Chief of Emergency Medicine: Harinder Dhindsa, MD, MPH, MBA, FACEP, FAAEM
Medical Director of Pediatric Critical Care Medicine: Mark Marinello, MD

Pediatric Endocrinology:
Mansi Kanhere, MD

CHoR Clinical Guidelines Committee:
Jonathan Silverman, MD

CHoR Quality Council, Executive Sponsor:
Jeniece Roane, MS, RN, NE-BC
José Muñoz, MD

References


Cooke PA, Subbarayan A, Odaka E, et al. Low dose (0.05 units/kg/hr) is comparable with standard dose (0.1 units/kg/hr) intravenous insulin infusion for the initial treatment of diabetic ketoacidosis in children with type 1 diabetes - an observational study. Pediatric Diabetes 2010: 11: 12-17


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Authors:
Rashida Woods, MD Melinda Penn, MD Celia Hanson, RN, CPEN
Kathryn Pace-Davis, CPNP Jonathan Silverman, MD

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Example: