Clinical Guideline

DKA
Pediatric Emergency & Critical Care

Inclusion criteria:
• Known Diabetes Mellitus
• Concern for new onset Diabetes Mellitus

If glucose >600 and/or osmolality>320, please see HHS/hyperosmolar DKA

This guideline should not replace clinical judgment.

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

• ABCs, GCS
• Vital signs, place PIV(s)
• 10 ml/kg NS bolus, repeat as necessary
• Discuss with PICU if given > 40 ml/kg

No

Shock resolved?

Yes

Evidence of cerebral edema?

Yes

• Consider mannitol 0.5-1 g/kg over 15 minutes
• If mannitol given, consider head CT
• Consider fluid restriction
• Discuss with Endocrine and PICU

No

Off algorithm, manage appropriately

Yes

DKA confirmed?

Yes

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

No

If glucose >600 and/or osmolality>320, please see HHS/hyperosmolar DKA

No

Bicarb >15
• If initial K>5, obtain EKG
• Discuss with Endocrine
• Consider SubQ insulin

Bicarb ≤ 15
• If initial K>5, 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

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

First approved: August 2018
Last reviewed: April 2022
Next expected update: April 2023

Children’s Hospital of Richmond at VCU

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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

<table>
<thead>
<tr>
<th>Initial Patient Info:</th>
<th>CHoR PICU Admission</th>
<th>Lab Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission weight:</td>
<td>Obtain GCS score¹</td>
<td>Expected initial labs (if not obtained prior to PICU admit, please obtain)</td>
</tr>
<tr>
<td>Previous weight:</td>
<td>Stabilize pt hemodynamically</td>
<td>VBG, BMP, Mag, Phos</td>
</tr>
</tbody>
</table>

Review OSH/ED Therapy

- Bolus amt of IV fluid: *IV rate calculation table page 2
- Hourly IVF started: *2-bag system titration, page 1
- Insulin therapy in ED: Start insulin infusion²

| VS every 2 hours, neuro check every hour | Expected initial labs (if not obtained prior to PICU admit, please obtain) |
| Strict I/Os | VBG, BMP, Mag, Phos |
| NPO | Every void ketones |

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 >7.1, 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
# 32-Bag System and Insulin Titration

If K+ < 5:

Bag 1: NS + KPhos 15mmol/L + KCl 20 meq/L

Bag 2: D10NS + KPhos 15mmol/L + KCl 20meq/L

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>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>0%</td>
</tr>
<tr>
<td>250-300</td>
<td>0.1</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>200-250</td>
<td>0.1</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>150-200</td>
<td>0.1</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>100-150</td>
<td>0.05-0.1</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>&lt;100</td>
<td>0.05</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>&lt;70</td>
<td>Off</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Additional actions:
- Notify Attending
  - Order D12.5 dextrose fluid
  - Recheck glucose every 30 min until >150

### 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>
</tbody>
</table>

Lab values:
- pH 72-73 or Bicarb < 15
- pH 71-72 or Bicarb < 10
- pH < 7.1 or Bicarb < 5

Time to rehydrate:
- 36 hours
- 36-48 hours
- 48 hours or more

Fluid Bolus:
- 10 ml/kg
- 10 ml/kg
- 10-20 ml/kg

### IV Fluid Rate Calculation

A. Deficit = _______% dehydrated x 10 x preadmission weight in kg

B. Hourly maintenance rate (4-2-1 rule) x total hours to replace

C. Add “A” and “B”

D. Total fluids given by outside hospital, EMS, and VCU ED

E. Subtract “D” from “C”. Will give you total remaining fluid to replace

F. Total hours remaining to infuse replacement fluids

G. Divide answer in “F” from “E” to obtain hourly replacement fluid rate

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

*Start insulin at 0.05 u/kg/hr if ≤ 5 years old

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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 100mg/dL of serum glucose above 100mg/dL
  • Example: If Serum Na is 127 mmol/L and serum glucose is 600 mg/dL: 600-100 = 500
    5 x 1.6 = 8
  Estimated corrected serum Na concentration is: 127 + 8 = 135mEq/L
• If patient develops hypernatremia (Na >145mmol/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 into the cells.
• If K+ is < 5mmol/L and patient is voiding, ensure sufficient K+ is added to IV fluids.
• If K+ is ≥ 5mmol/L, DO NOT add K+ to IV fluids until patient is voiding and K+ is < 5mmol/L
• Subsequent potassium replacement therapy can be based on serum potassium

Chloride (Cl-):
• If hyperchloremia develops (Cl- >115mmol/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 0.5-1g/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 long acting insulin and diet tray; THEN give short acting insulin
  • Stop dextrose containing IV bag and insulin drip 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

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References


Cooke PA, Subbarayan A, Odeka 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


Citation

Title: DKA Guideline
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Date: August 2021
Retrieval website: http://www.chrichmond.org/clinicalguideline-DKA

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