Clinical Guideline

DKA

Pediatric Emergency & Critical Care Medicine

This guideline should not replace clinical judgment.

Inclusion criteria:

- Known Diabetes Mellitus
- Concern for new onset Diabetes Mellitus
- POC Blood glucose > 200

Begin → **DKA suspected?**

- **No** → Off algorithm, look for alternative diagnosis
- **Yes** →

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

  → **Shock resolved?**
  - **Yes** → **Evidence of cerebral edema?**
  - **No** → Off algorithm, manage appropriately
- **No** → **Evidence of cerebral edema?**

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** → **10 ml/kg NS bolus over 1 hour**

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

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

- **No** → Off algorithm, look for alternative diagnosis. Consult endo for hyperglycemia without DKA
- **Yes** →

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

CHILDREN'S HOSPITAL OF RICHMOND AT VCU

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

chrichmond.org
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Subsequent/PICU Phase

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:	CHoR PICU Admission	Lab Assessment
Admission weight:	Obtain GCS score[1]	Expected initial labs (if not obtained prior to PICU admit, please obtain)
Previous weight:	Stabilize pt hemodynamically	VBG, BMP, Mag, Phos
Review OSH/ED Therapy	Start 2 bag system[3]	CBC, Osm, Amylase, Lipase
Bolus amt of IV fluid:	*IV rate calculation table page 2	LFTs, UA, Hgb A1C
Hourly IVF started:	*2-bag system titration, page 1	Routine PICU Labs
Insulin therapy in ED:	Start insulin infusion[2]	Every hour glucose (on insulin drip)
	VS every 2 hours, neuro check every hour	Every hour VBG (until pH >7.1)
	Strict I/Os	Every 4 hours BMP, mag, phos
	NPO	Every void ketones
	Endocrine consult	

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

[2]Insulin 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]2-Bag System and Insulin Titration

Total IVF rate = Bag 1 _____ml/kg + Bag 2 _____ml/kg

If K+ <5:	**If K+ ≥ 5:**
Bag 1: NS + KPhos 15mmol/L + KCl 20 meEq/L	Bag 1: NS
Bag 2: D10NS + KPhos 15mmol/L + KCl20mEq/L	Bag 2: D10NS
	Add KPhos and KCl once K+ falls <5

Serum glucose mg/dL	**Insulin u/kg/hr***	**NS Bag % of IV fluids**	**Dextrose Bag % of IV fluids**	**Additional actions**
>300	0.1	100%	0%	
250-300	0.1	50%	50%	
200-250	0.1	25%	75%	
150-200	0.1	0%	100%	
100-150	0.05-0.1	0%	100%	Recheck glucose in 30 minutes
<100	0.05	0%	100%	**Notify Attending** • Order D12.5 dextrose fluid • Recheck glucose every 30 min until >150

<70	Off	0%	100%	**Notify Attending**
				• Stop insulin infusion
				• If no change in mentation: give juice
				• If change in mentation:
				  • Bolus with 2 ml/kg of D25 over 5 mins
				  • Check glucose q15mins until >150 mg/dL

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

Calculations:

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

Hydration Status	**Mild dehydration**	**Moderate dehydration**	**Severe dehydration**
% dehydration/change in weight	<5%	5-9%	>10%
Lab values	pH 7.2-7.3 or Bicarb <15	pH 7.1-7.2 or Bicarb <10	pH <7.1 or Bicarb <5
Time to rehydrate	36 hours	36-48 hours	48 hours or more
Fluid Bolus4	10 ml/kg	10 ml/kg	10-20 ml/kg

[4]Post ED, bolus only used for hemodynamic instability as per PALS algorithm. Excess fluid resuscitation may cause fluid shifts that can increase the risk of cerebral edema. Rehydration should occur over 24-48 hours

In order to more accurately capture rate of rehydration, the following calculation tool can be used.

IV Fluid Rate Calculation

A. Deficit = _____% dehydrated x 10 x preadmission weight in kg _____ ml
B. Hourly maintenance rate (4-2-1 rule) x total hours to replace _____ ml
C. Add "A" and "B" =_____ ml
D. Total fluids given by outside hospital, EMS, and VCU ED _____ ml
E. Subtract "D" from "C". Will give you total remaining fluid to replace =_____ ml
F. Total hours remaining to infuse replacement fluids _____ hours
G. 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 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

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

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

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