Pediatric Diabetic Ketoacidosis

Its not all about the sugar

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ORLANDO HEALTH | ARNOLD PALMER HOSPITAL For Children

Triage

- 9 yo F
- T: 97.7F / HR: 160/ RR: 30/ BP 109/67/ O2% 100
- Transported to APH via EMS as a MEDICAL RED for AMS, GCS 10
- 1 wk h/o polyuria, polydipsia, polyphagia and several episodes of emesis x 2 days. Seen at outside urgent care last night, diagnosed with viral gastroenteritis, and discharged home with Zofran and told to orally rehydrate. Today she had worsening emesis and lethargy with AMS.

Constitutional:
Appearance: She is toxic-appearing.
Comments: **Underweight**
HENT:
Head: Normocephalic.
Right Ear: Tympanic membrane and external ear normal.
Left Ear: Tympanic membrane and external ear normal.
Nose: Nose normal. No congestion or rhinorrhea.
Mouth/Throat:
Mouth: Mucous membranes are dry.
Eyes:
Extraocular Movements: Extraocular movements intact.
Conjunctiva/sclera: Conjunctivae normal.
Pupils: Pupils are equal, round, and reactive to light.
Comments: **Sunken eyes**
Cardiovascular:
Rate and Rhythm: Tachycardia present.
Pulses: Normal pulses.
Heart sounds: No murmur.
Pulmonary:
Effort: Tachypnea present. No retractions.
Breath sounds: No wheezing.
Comments: **Kussmaul breathing**
Abdominal:
Tenderness: There is no abdominal tenderness.
Skin:
Capillary Refill: Capillary refill takes more than 3 seconds. **Capillary refill 5 seconds**
Coloration: Skin is pale.
Comments: **Cold to touch in lower extremities up to the knees**
Neurological:
Mental Status: She is oriented for age.
GCS: GCS eye subscore is 4. GCS verbal subscore is 2. GCS motor subscore is 4.

Lab Results as of 2210

	POCT Whole Blo... 5 months ago
Sodium - POC	134 ↓
Potassium - POC	4.9
Ionized Calcium - POC	1.49 ↑
Glucose - POC	476 ↑↑
Hemoglobin - POC	15.3 ↑
Hematocrit Calc - POC	46.9 ↑
Lactic Acid Venous P...	1.6
pH, Venous POC	<6.82 ↓↓
pO2, Venous POC	36
pCO2, Venous POC	25
SO2, Venous POC	63.9
Base Excess, Venou...	—
HCO3, Venous POC	3.3 ↓
TCO2 calc, Venous P...	4.1 ↓
Specimen Type POC	Venous

Beta Hydroxybutyrate

07/27 1319

Beta-Hydroxybut…	11.2 ▲

CBC

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Auto WBC	60.8 ⏫
RBC	5.32 ▲
HEMOGLOBIN	14.8 ▲
HEMATOCRIT	47.3 ▲
MCV	88.9
MCH	27.8
MCHC	31.3 ▼
RDW	14.0 ▲
Platelets	503 ▲
MPV	10.6 ▲

Basic metabolic panel

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Sodium	128 ▼
Potassium	4.9
Chloride	101
CO2	3 ⏬
Glucose	529 ⏫
BUN	25
Creatinine	0.79
BUN/Creatinine…	31.6 ▲
Calcium	9.5
Osmolality Calc	297
Anion Gap	24 ▲
eGFR	

Diagnosis?

DKA!

APH Diabetic Ketoacidosis Management Protocol - Emergency Department

- Eligible Patients
  - Diagnosis of diabetic ketoacidosis
  - Needs admission to PICU or PSCU
- Initial management: no bicarbonate bolus, no insulin bolus, patient should have at least 2 PIVs or a CVL
  - Administer 10 cc/kg 0.9 % NS bolus (give over 1st hour of resuscitation)
    - Repeat 10 cc/kg 0.9% NS bolus over 2nd hour prn inadequate organ perfusion
  - LABS in ER (ON ARRIVAL):
    - Whole blood (AND Q1h while in the ER)
    - CBC
    - Beta-hydroxybutyrate
    - BMP
    - UA
- Insulin
  - Insulin gtt at 0.1 units/kg/hr
- Intravenous fluids
  - IVF rate in ml/hr = **2x Maintenance Rate**
    (or use actual fluid calculation: (84 ml/kg – bolus given) /23 hr + maintenance rate)
  - Potassium:
    - Default: include potassium if K < 5.5
    - If K ≥ 5.5, use two-bag system without potassium
    - If K < 4, use two-bag system with 60meq/L potassium (30 meq/L Kacetate + 30mmol/L KPhos)
    - If K < 3, hold insulin drip until IVF are started

- Two-bag system: order both bags simultaneously STAT

	½ NS + 20meq/L K-acetate + 20mmol/L KPhos	D_{10} ½ NS + 20meq/L K-acetate + 20mmol/L KPhos
INITIAL BLOOD GLUCOSE <500		
Serum glucose	Percent of IVF	Percent of IVF
>350	100% = ____ mL /hr	0%
250-349	50%= ____ mL /hr	50%= ____ mL /hr
100-249	0%	100%= ____ mL /hr
< 100	Notify physician	
INITIAL BLOOD GLUCOSE ≥ 500		
Serum glucose	Percent of IVF	Percent of IVF
>500	100%=___ ml/hr	0%
400-499	75%=___ ml/hr	25%=___ml/hr
300-399	50%=___ml/hr	50%=___ml/hr
200-299	25%=___ml/hr	75%=___ml/hr
100-199	0%	100%=___ml/hr
<100	Notify physician	

*If blood glucose drops by more than 100 mg/dL in one hour contact physician

- NURSING
  - VS q30min
  - Neuro checks Q30min
  - Notify H.O. for vomiting, confusion, agitation, bradycardia, urinary incontinence, abnormal neurological exam, headache, or if BG drops by more than 100 mg/dL in 1 hr

ED Course Cont.

- Head of bed was elevated
- Mannitol 1GM/kg was given within 15 minutes of arrival
  - Initially GCS improved slightly but again slowly deteriorated to 10
- Hypertonic saline (3%) 6ml/kg was subsequently given
  - No immediate improvement
- CT Head was concerning for cerebral edema
- Child was admitted to PICU in critical condition

PICU Course

- She remained obtunded but would intermittently open her eyes and answer questions
- Repeat Whole Blood profile; pH 6.67 / HCO3 1.8
- Received a 3rd 10cc/kg normal saline bolus and 2mEq/kg of Sodium bicarbonate
- 24hrs → Acidosis corrected
- 1 day 22hrs → Mentation at baseline, converted to subcutaneous insulin and discharged from PICU

Since discharge from APH

- She is doing great!
  - Last seen by APH Endocrinology November 2021
  - HgbA1c was 7.1%
  - Starting to carb count and adjust Humalog sliding scale accordingly

A needle in a haystack – Diagnosing DKA

- New onset diabetic VS known diabetic
- Symptoms;
  - Polyuria, polydipsia, polyphagia
  - Abdominal pain, vomiting
  - Dehydration, lethargy
  - Headache, AMS
  - Clear shallow tachypnea
  - Weight loss
  - Fruity smelling breath

Diagnostic Criteria of DKA

- Glucose > 200mg/dl
- pH < 7.3
- Bicarbonate < 15-18 mEq/L
- + Urine ketones
- + Serum ketones (Beta hydroxybutyrate)

Most feared emergent complication

- Cerebral Edema
  - Risk factors
    - Age < 3 yo
    - Elevated BUN/Creatinine
    - Low PCO2
    - *Administration of Bicarbonate*

It’s a fluid problem!

Allegations

The patient’s family filed a lawsuit against Pediatrician A, Pediatrician B, the hospital, Emergency Medicine Physician A, and the pediatric endocrinologist. It was alleged that improper management of DKA resulted in the patient’s brain herniation and death.

Landmark Study – 2018 NEJM

ORIGINAL ARTICLE

Clinical Trial of Fluid Infusion Rates for Pediatric Diabetic Ketoacidosis

Nathan Kuppermann, M.D., M.P.H., Simona Ghetti, Ph.D., Jeff E. Schunk, M.D., Michael J. Stoner, M.D., Arleta Rewers, M.D., Ph.D., Julie K. McManemy, M.D., M.P.H., Sage R. Myers, M.D., M.S.C.E., Lise E. Nigrovic, M.D., M.P.H., Aris Garro, M.D., M.P.H., Kathleen M. Brown, M.D., Kimberly S. Quayle, M.D., Jennifer L. Trainor, M.D., et al., for the PECARN DKA FLUID Study Group*

Take home points for Pediatric DKA

When in doubt get a finger stick glucose

Its OK to give fluids

Don’t give a BICARBONATE bolus…

Don’t give an INSULIN bolus

Cerebral Edema is a clinical diagnosis

Diagnostic Criteria

- Abnormal motor or verbal response to pain
- Posturing
- Cranial nerve palsy (III,IV,VI)
- Neurologic respirations (Grunting, Cheyne Stokes)

Major Criteria

- AMS
- Heart rate decelerations not due to sleep or improved hydration
- Age inappropriate incontinence

Minor Criteria

- Vomiting
- Headache
- Lethargy
- Diastolic BP > 90
- Age < 5 yo

Treatment of Cerebral Edema

- Mannitol → 1GM/kg over 20 min
- Hypertonic saline (3%) → 6ml/kg
- Intubation
  - Avoid if at all possible!
  - Dx of Cerebral edema does NOT require intubation!

THANK YOU