UCDAVIS HEALTH | CHILDREN'S HOSPITAL

PEDIATRIC DIABETIC KETOACIDOSIS (DKA)

TREATMENT PROTOCOL

GENERAL CONCEPTS

- Calculate serum osmolality: 2[Na(+)] + Blood Glucose(mg/dL)/18 + BUN(mg/dL)/2.8
- If this patient has: Plasma glucose above 600 mg/dL , AND minimal or no acidosis, AND minimal or no ketosis, AND osmolality greater than325 mOsm/kg, do not use DKA PROTOCOL. Instead use HHS PROTOCOL.
- If this patient has: Plasma glucose above 600mg/dL AND serum osmolality greater than 325mOsm/kg with ketosis/acidosis, use HYPEROSMOLAR DKA PROTOCOL.
- DKA causes anion gap metabolic acidosis due to production of ketoacids (beta-hydroxybutyrate & acetoacetate), causing extracellular shift and osmotic diuresis Exam and vital signs underestimate total body fluid deficits. It is generally safe to assume 5-10% dehydration, and plan to replace this over 24-48h
- Acidosis will correct with treatment; administration of bicarbonate is not recommended unless symptomatic hyperkalemia is present or CPR/resuscitation is necessary. It may increase risk for cerebral injury, worsen intracellular acidosis and hypokalemia
- Cerebral injury is the leading cause of morbidity and mortality in DKA (see below)
- Total body stores of all electrolytes (Na, K, Phos, Mag) are low in DKA due to renal losses
    - Na corrected = Na measured + 1.6 x [(Glucose-100)/100]; should normalize with treatment
    - Serum K may be high/normal/low, but total body stores are low
    - Low Phosphorous can lead to poor oxygen delivery to tissues

- ** For patients with known diabetes that use an insulin pump: please ensure that the insulin pump and infusion site are disconnected from the patient.

ED/PICU MANAGEMENT INITIAL RESUSCITATION/REHYDRATION

- Use actual body weight for fluid calculations (not ideal body weight)
- Do not administer bicarbonate unless symptomatic hyperkalemia or CPR/resuscitation
- Initial bolus: 20 ml/kg NS over 30 minutes. Can be repeated if evidence for inadequate organ perfusion on reassessment
- After bolus, start 0.9% NaCl at 2x maintenance until “2 bags” are available.
- If blood glucose falls below 300 mg/dL before “2 bags” available, switch to D5 0.9% NaCl

INSULIN

- Do not bolus insulin
- Order insulin infusion 0.1 Units/kg/hr as soon as possible
- **Known patients with diabetes**: Give PM or AM Lantus dose at usual time; simultaneously decrease insulin infusion by 0.03 Units/kg/hr (e.g., a known patients with diabetes still in DKA has her insulin infusion decreased from 0.1 Units/kg/hr to 0.07 Units/kg/hr with home evening Lantus administration)
- **New diagnosis of diabetes:** If patient is still receiving insulin infusion between 8pm-MN, give an evening subcutaneous basal dose (0.3units/kg/day) and decrease insulin infusion to 0.07Units/kg/hr. Further adjustments to insulin infusion may be necessary.
- Begin infusion 1 hour AFTER start of fluid resuscitation
    - Goals:
        - Lower glucose 50-100 mg/dL every hour
        - Maintain blood glucose 150-250 mg/dL while on infusion

- Consider decreased rate (0.05 Units/kg/hr) and/or delayed start of insulin infusion if severe hyperglycemia (greater than 1000 mg/dL) with mild acidosis
- Consider decreased rate if glucose decline is greater than 100 mg/dL per hour
- Continue IV insulin until HCO3 17 – 20 mEq/L

IV FLUIDS – "TWO-BAG" SYSTEM

- For patients with known or suspected cerebral injury, use clinical judgment in selection and titration of fluids.
- Begin replacement fluids as soon as possible.
- Start 0.9% NS at 2x maintenance for blood glucose greater than or equal to 300mg/dL until the 2 bags are available
    - If blood glucose falls to less than 300mg/dL before the 2 bags are available, switch to D5 0.9% NaCl PICU will place admission orders for "2 bags" fluids as below (ED may order specialized fluids if anticipated delay in PICU orders).
- Do not start the potassium-containing fluids if:
    - K greater than 5.5 on admission. If K greater than 6, obtain ECG
    - Urine output/renal function have not been ensured
- Consider using 0.9% NaCl fluids with electrolytes if corrected Na less than 140 or Na falls with treatment. Do not use hypotonic fluids if corrected Na falls less than 130.
- Nurse to titrate each bag as patient glucose decreases

Blood glucose (mg/dL)	BAG #1 0.45% NaCl with 20mEq K Acetate + 20mEq K Phos (13.6mM) Rate (% of total)	BAG #2 D10 0.45% NaCl with 20mEq K Acetate + 20mEq K Phos (13.6mM) Rate (% of total)
greater than or equal to 300	100%	0%
200 – 299	50%	50%
less than 200	0%	100%

IV FLUID RATE CALCULATIONS

- For simplicity, use 2 x maintenance IVF rate (to approximate 5-10% dehydrated, and account for prior resuscitation)
- Maintenance fluid rate calculation:
    - 4 ml/kg for the first 10kg , ml/kg for the next 10kg, 1 ml/kg for each kg over 20kg
- Urinary replacement is not necessary, but can be considered if UOP greater than fluid intake over 6h. Refer to hyperosmolar DKA protocol for replacement guidelines.

MONITORING

Vitals q1h, continuous Intake/Output, Neuro checks q1h (q30min if headache and/or altered mental status) Laboratory Monitoring (should be obtained with STAT priority)

Admission	Q1h	Q3h	Q6h
VBG or ABG with lytes BMP, Mg, Phos Amylase/Lipase Hemoglobin A1c Diabetes antibodies (new onset only) Infectious w/u as indicated (CBC, inflammatory markers, cultures, urine studies)	POC glucose	VBG or ABG with lytes Phos if admission less than 3	VBG or ABG BMP, Mg, Phos

CEREBRAL INJURY

- Typically occurs 4-12 hours after treatment is initiated (but can occur prior to and up to 24-48 hours after)
- Risk factors
    - Age less than 3 years
    - pH less than 7.0

- Failure of measured serum Na to rise during treatment
- Administration of bicarbonate therapy unless symptomatic hyperkalemia or CPR/resuscitation
- Elevated BUN (27 ± 14 mg/dL) at presentation
- Low PaCO2 levels (11.3 ± 6.5 mm Hg) at presentation

- Diagnosing Clinically Significant Cerebral Injury (Muir, et al)
  - Presence of either of the following has a sensitivity of 92% for detecting cerebral injury in the setting of DKA
    - 1 Diagnostic Criteria - or –
    - 2 Major Criteria - or -
    - 1 Major Criteria and 2 Minor Criteria Diagnostic Criteria

Diagnostic Criteria	Abnormal motor or verbal response to pain Decorticate or decerebrate posture Cranial nerve palsy (especially III, IV, and VI) Abnormal neurogenic respiratory pattern (e.g., grunting, tachypnea, Cheyne-Stokes respiration, apneusis)
Major Criteria	Altered mentation/fluctuating level of consciousness (GCS less than or equal to 13) Sustained heart rate deceleration (decline greater than 20 bpm) not attributable to improved intravascular volume or sleep state Age-inappropriate incontinence
Minor Criteria	Vomiting Headache Lethargy or not easily arousable from sleep Diastolic blood pressure greater than 90 mmHg Age less than 5 years

If cerebral injury is suspected, treat immediately with Mannitol or 3% NaCl before any neuroimaging

TRANSITION TO SUBCUTANEOUS INSULIN

- Criteria;
    - Mental status normal
    - Able to tolerate sips of clears
    - HCO3 17-20 mEq/L
- Process:
    - Administer the first subcutaneous insulin dose (Lantus and/or NovoLog) If possible, give just prior to breakfast or dinner; however, depending on clinical scenario can be given at any time
    - Stop the insulin infusion ONE HOUR after administering subcutaneous basal (Lantus) insulin.
        - **If SQ basal insulin was administered concurrently with insulin infusion, discontinue insulin infusion without one hour overlap
        - **If patient uses an insulin pump, restart insulin pump 1-2 hours prior to discontinuing insulin infusion.
    - Allow the patient to start eating; if transition does not align with meal time, give a sugar free or low carb snack (less than5g carbohydrates)
    - Discontinue IVF when the insulin infusion is discontinued and the patient is able to maintain adequate oral hydration Dextrose should be removed from IVF when insulin infusion is discontinued
    - Transition to new lab frequency: POC glucose before meals, nightly, at 2-3am (qAC, nightly and PRN), PRN UA for ketones if BG greater than 350 and/or N/V

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