2-YEAR-OLD MALE WITH HYPERGLYCEMIA

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PEDIATRIC ENDOCRINOLOGY FELLOW
OCTOBER 30, 2014
CHIEF COMPLAINT

- 29/12 yo healthy M presents with hyperglycemia, polyuria, polydipsia, and weight loss.
HPI

- Admitted to an OSH for abd pain and constipation
- Blood glucose (BG) noted to be 1352
- Additional labs: pH 7.42, bicarb 15, BG 1052, Na 120 (corrected 145)
  - Received NS bolus x1 → transferred to Comer PICU
- Endocrine was consulted for management of new-onset diabetes mellitus (DM) with concern for hyperglycemic hyperosmolar state (HHS)

INITIAL THOUGHTS?
HPI

• 2 wks ago: polyuria (6+ large diapers/day) and polydipsia (32 oz juice/water daily)
  • Urine appeared more clear than normal
• Over last 1 wk: lost 2 lbs, increased fussiness
REVIEW OF SYSTEMS

- Constitutional: fever, fatigue, fussy, weight loss, decreased appetite
- Endo: temp intolerance, hyperglycemia, polyuria, polydipsia
- HEENT: congestion, rhinorrhea, ear infection
- GI: abd pain, constipation
- Neuro: headaches, light-headedness
- Skin: rash
- Psych/Behavioral: increased fussiness
FURTHER HISTORY

• PMH: Constipation
• PSH: None
• FH:  
  • Gestational DM - mother  
  • T2DM - maternal aunt and uncle
• SH: Lives with parents and maternal grandparents. At home with mother during the day.
• Allergies: NKDA
• Meds: Miralax prn, amoxicillin (day 6/10)
• **Vitals:** T 36.5, HR 103, BP 89/50, RR , Wt 13 kg (26%ile), Ht 103 cm (99%ile)
• **General:** well-appearing, NAD, fussy but consolable
• **HEENT:** moist mucous membranes, nL EOM
• **Neck:** supple, no adenopathy, no thyromegaly
• **CV/Resp:** RRR, brisk cap refill, CTAB
• **GI:** soft, no distension, non-tender, +BS
• **GU:** prepubertal male genitalia, Tanner 1 pubic hair
• **Neuro:** alert, nL muscle tone
• **Skin:** warm, no rash, no acanthosis nigricans
LABS

- VBG: 7.32/28.9/59.9/-10
- CMP: 135 93 14 708
  4.5 13 0.6
  Ca 9.8, phos 4.7, Mg 2.3
- Serum Osm 324
- Liver panel: WNL
- CK 39
- HbA1C 12.6%
- BOHB 7.33
- C-peptide 0.5
- Insulin <2
1. Could our pt have had HHS?
HHS

- Characterized by extreme elevations in BG and hyperosmolality without significant ketosis
- Typically occurs in pts with some endogenous insulin production (e.g. T2DM)
  - Enough to suppress ketosis without decreasing hepatic gluconeogenesis
- Seen in ~4% of new-onset T2DM
- Mortality = 23-37% (adults), 12-14% (children/adolescents)
PATHOPHYSIOLOGY OF HHS

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<tr>
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<th>DKA</th>
<th>HHS</th>
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<tr>
<td>BG</td>
<td>&gt;200 mg/dL</td>
<td>&gt;600 mg/dL</td>
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<tr>
<td>pH</td>
<td>&lt;7.3</td>
<td>&gt;7.25</td>
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<tr>
<td>Bicarb</td>
<td>&lt; 15 mmol/L</td>
<td>&gt;15 mmol/L</td>
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<tr>
<td>Ketones</td>
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<tr>
<td>Osm</td>
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<td>&gt;330 mOsm/kg</td>
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<tr>
<td>Dehydration</td>
<td>Mild-severe</td>
<td>Severe</td>
</tr>
<tr>
<td>Electrolyte</td>
<td>Mild-severe</td>
<td>Severe</td>
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<td>Deficits</td>
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CLINICAL QUESTIONS

1. Could our pt have had HHS?
2. Should HHS be considered in young pediatric pts?
Decr appetite, polyuria, polydipsia, vomiting, loose stools x3 days. No h/o excessive glc intake.

Labs: pH 7.22, Na 126, bicarb 10, glc 2400, BUN 85, serum Osm 428, urine acetone 2+
CLINICAL QUESTIONS

1. Could our pt have had HHS?
2. Should HHS be considered in young pediatric pts?
3. What are the differences in management between HHS and hyperosmolar DKA (hDKA)?
HYPEROSMOLAR DKA

- relative or absolute insulin deficiency
- physiologic stress
- ↑ levels of glucagon, catecholamines, and cortisol
  - ↑ gluconeogenesis
  - ↑ glycogenolysis
  - ↓ glucose utilization
- ↑ intake of sugar-containing fluids
- hyperglycemia
  - ↑ osmotic diuresis
  - ↑ loss of free water, electrolytes

MANAGEMENT: HHS VS hDKA

**Fluids**
- Bolus 0.9% saline 20 cc/kg, repeat until perfusion established
- Maintenance fluids plus deficit replacement over 24-48 hours; 0.45-0.75% saline

**Electrolytes**
- When serum K⁺ <5 mEq/L, start replacement with K⁺ 40 mEq/L
- Monitor electrolytes, calcium, magnesium, phosphate every 2-4 hours
- Replace urine output

**Insulin**
- HHS: Start insulin infusion when BG no longer decreases with fluid alone
- IV regular insulin 0.025-0.05 unit/kg/hr

**Hyperosmolar DKA**
- Start insulin after initial fluid bolus
- IV regular insulin 0.05-0.1 unit/kg/hr depending on degree of acidosis

**Titrating insulin dose to decrease blood glucose 75-100 mg/dL per hour**

**Frequently assess circulatory status**
**Adjust rate and electrolyte composition of fluids as needed**
BACK TO OUR PATIENT...
#### RECOMMENDATIONS

- NS bolus 10 mL/kg x1
- IVF with NS to replace 4000 mL/m2 over 36 hours
- Begin insulin at 0.05 u/kg/hr once the BG drops by <50 mg/dL/hr

#### POC BGs:

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#### BO HB:

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Insulin 0.5 u/kg/hr
FURTHER MANAGEMENT

• Transitioned to SQ insulin 22 hours after initiation of insulin ggt and 48 hours after admission
• Received DM education
• Scheduled to f/u at DCAM
• Discharged home on hospital day 4
SUMMARY

• HHS is typically seen in adolescents and adults with T2DM
• Rehydration with sugar-containing fluids → hDKA
• Rate of IVF for HHS and hDKA > DKA to maintain adequate circulatory volume
  • aggressive hydration and appropriate fluid replacement may ↓ complication rates
• Insulin is necessary to resolve ketosis
  • deferred until after an initial fluid bolus
• Serum K and phosphorus should be carefully monitored
  • K every 2-3 hrs, phosphorus every 3-4 hrs


