Welcome

DKA and HHS

CDE Exam Preparation
Presented by
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Pathophysiology of diabetic ketoacidosis

1. Hyperglycemia
   - ↑ plasma osmolality
     - Intracellular dehydration
     - Osmotic diuresis
       - Electrolyte loss (Na⁺, K⁺, PO₄, Mg²⁺)
       - ↓ ECF volume
         - Shock
         - ↓ GFR
           - ↑ glucose
           - ↑ acidosis
           - azotemia (↑ BUN)
DKA at organ level

Pathogenesis of Diabetic Ketoacidosis

- Decreased vascular resistance
- Nausea
- Vomiting
- Abdominal pain
Diabetic Ketoacidosis

Characteristics

- Ketones positive
- Anion Gap > 12 (High)
- Blood Sugar > 14 (High)
- Bicarbonate < 15 (Low)
- PH < 7.3 (Low)
- Sodium Normal or Low
- Potassium Normal, Low, High

Monitor every hour until fluid and acidosis is corrected (electrolytes, creatinine, osmolality, fluid balance)

Pregnant women in DKA present with lower glucose levels than non-pregnant women
Diabetic Ketoacidosis

Characteristics

- Quick Less 24 hours
- Polyuria, polyphagia, polydipsia
- Kussmaul respiration
- Nausea and Vomiting
- Tachycardia
- Hypotension
- Leg cramps
- Abdominal pain
- Decreased Extracellular volume (ECFV)
- Weakness, weight loss
- Physical symptoms of dehydration
Diabetic Ketoacidosis

Causes

- Newly Diagnosed Type 1
- Insulin Omission
- Infection
- MI
- Trauma
- Flu
- Eating Disorders (20% recurrent)
- Pump Failure
- Thyrotoxicosis
- Cocaine, atypical antipsychotics, interferon
Hyperosmolar Hyperglycemic State (HHS)

Characteristics

• Dehydration, Marked Decreased Extracellular volume
• Blood Sugar >33
• Osmolatity > 350
• PH > 7.2
• Bicarb >20
• Ketones +/-

Can have neurologic presentation, seizures and stroke like symptoms
Symptoms

- Dry Mouth
- Poor Urine Output
- Sleepy coma
- Stupor
- Increased BUN, Cr
Causes

- Illness
- Decreased Fluid intake
- Drugs - glucocorticoids, thiazides, lithium and atypical antipsychotics
- Elderly, chronic care
- Following cardiac surgery
Tests

Glucose
Electrolytes and anion gap
Creatinine
Osmolality
Blood gases
Serum and urine ketone
  • Beta-hydroxbutyric acid (78%)
  • Acetoacetate (20 %)
  • Acetone (2%)
Fluid balance

Monitor
Level of consciousness
Precipitating factors
<table>
<thead>
<tr>
<th></th>
<th><strong>DKA</strong></th>
<th><strong>HHS</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Blood Sugar</strong></td>
<td>&gt; 14</td>
<td>&gt;34</td>
</tr>
<tr>
<td><strong>Ketones</strong></td>
<td>Positive</td>
<td>+ / -</td>
</tr>
<tr>
<td><strong>Osmolality</strong></td>
<td>Normal</td>
<td>&gt; 350</td>
</tr>
<tr>
<td><strong>PH</strong></td>
<td>&lt; 7.3</td>
<td>&gt; 7.2 (normal)</td>
</tr>
<tr>
<td><strong>Anion gap</strong></td>
<td>increased</td>
<td>normal</td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td>Rapid</td>
<td>Slower</td>
</tr>
<tr>
<td><strong>Characteristics</strong></td>
<td>Weight Loss</td>
<td>Illness</td>
</tr>
<tr>
<td>Common to Both</td>
<td>Vomiting</td>
<td>Dehydration</td>
</tr>
<tr>
<td></td>
<td>Abdominal pain</td>
<td>Stupor</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td>Insulin (0.1u/kg/h)</td>
<td>Hydration</td>
</tr>
<tr>
<td></td>
<td>Hydration</td>
<td>Insulin</td>
</tr>
<tr>
<td><strong>Mortality</strong></td>
<td>&lt; 1 % (age 20- 49)</td>
<td>12- 17 %</td>
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<td></td>
<td>16% (over 75)</td>
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<tr>
<td><strong>Incidence</strong></td>
<td>4-9 %</td>
<td>&lt; 1 %</td>
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<td>hospital admissions US</td>
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</table>
**Treatment**

### DKA

**Fluid resuscitation**
- Avoid Hypokalemia
- Insulin
- Avoid rapidly falling serum osmolality

**Causes**

### HHS

**Fluid resuscitation**
- K
- Bicarb
- Electrolytes

**Avoid Hypokalemia**
- Avoid rapidly falling serum osmolality

**Causes**
- Insulin

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**Concerns:** Cerebral Edema if hyperosmolality is reduced quickly (only 3 mmol/kg/hr)
Wendy’s attempt to simplify Diabetic Ketoacidosis

**Insulin Deficiency**
- Increased gluconeogenesis
- Increased glycogenolysis
- Decreased glucose utilization by liver, muscle, fat

**Type 1**
- Glucagon is increased

**Type 2**
- Increased Catecholamines
- Suppresses insulin release

**Hyperglycemia**
- Ketones

**Acidosis**
- Urinary Water Loss (Na, K, Cl)
- Extracellular Fluid Volume depletion

**Increased Cortisol**
- Increased gluconeogenesis
- Increased glycogenolysis
- Decreased glucose utilization by liver, muscle, fat

Wendy’s attempt to simplify Diabetic Ketoacidosis
Wendy’s attempt to simplify

Hyperosmolar Coma

Hyperglycemia

Underlying condition

Urinary Water Loss (Na, K, Cl)

Extracellular Fluid Volume depletion

Insulin is still present but inadequate to control blood glucose, but adequate to prevent formation of ketones.
Case Study

Judy was brought to hospital by her husband. She has been weak and sleepy for the last 24 hours. She is now complaining of abdominal pain.

What blood tests would you look at to determine if this is DKA or HHS?

a) Blood Glucose, anion gap, urine ketones, bicarbonate
b) Ethanol, salicylate, acetaminophen
c) Insulin levels, blood ketones
d) Blood glucose, anion gap, blood ketones, pH, bicarbonate
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good luck.