WCU DIABETES EDUCATION SUMMIT

Sick Day Care
Illness, Trauma, Surgery, etc. frequently aggravate glycemic control.

- Diabetic Ketoacidosis
- Hyperglycemic Hyperosmolar State (nonketotic)
DKA/HHS

- Causes of morbidity & mortality
- Characterized by insulinopenia & severe hyperglycemia
- Clinically differ based on state of dehydration and severity of metabolic acidosis
~144,000 hospital admissions per year for DKA in the U.S.
The rate of hospital admissions for HHS is lower than for DKA, accounting for <1% of all diabetes-related admissions
Initial manifestation of diabetes in 20% of adult patients.

Initial manifestation of diabetes in 30-40% of children with T1D.

Common precipitating factors for DKA: infections, intercurrent illnesses, psychological stress, and poor compliance of therapy.
Initial manifestation of diabetes in 7-17% of patients.

Commonly occurs in older adults with T2D who are residents of nursing homes.

Infection is major precipitating factor.
PATHOGENESIS

Absolute Insulin Deficiency

- ↑ Lipolysis
- ↑ FFA to liver
- ↑ Ketogenesis
- ↓ Alkali reserve
- ↑ Ketoacidosis
- Triacylglycerol
- Hyperlipidemia

Counterregulatory Hormones

- ↓ Protein synthesis
- ↑ Proteolysis
- ↑ Gluconeogenic substrates
- ↓ Glucose utilization
- ↑ Gluconeogenesis
- ↑ Glycogenolysis
- Hyperglycemia
- Glycosuria (osmotic diuresis)
- Loss of water and electrolytes
- Dehydration
- Decreased fluid intake
- Impaired renal function

Relative Insulin Deficiency

- Absent or minimal ketogenesis

DKA

HHS

Hyperosmolarity
SIGNs & SYMPTOMS

**DKA**
- Rapid onset, <24 hours
- Polyuria, polydipsia & weight loss
- Vomiting/abdominal pain (40-75% of cases)
- Signs of dehydration
- Altered mental status (varies)

**HHS**
- Onset= days to weeks
- Polyuria, dehydration & severe decline in level of consciousness
- No signs of metabolic acidosis
- Neurologic signs/seizures
- Osmolality >330mOsm/kg
LABORATORY FINDINGS

- DKA consists of a triad of hyperglycemia, hyperketonemia, & high anion gap metabolic acidosis.
- HHS will be absent of metabolic acidosis.
Table 1: Diagnostic criteria for DKA and HHS

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>HHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma glucose (mg/dl)</td>
<td>&gt;250</td>
<td>&gt;250</td>
<td>&gt;250</td>
<td>&gt;600</td>
</tr>
<tr>
<td>Arterial pH</td>
<td>7.25–7.30</td>
<td>7.00–7.24</td>
<td>&lt;7.00</td>
<td>&gt;7.30</td>
</tr>
<tr>
<td>Serum bicarbonate (mEq/l)</td>
<td>15–18</td>
<td>10 to &lt;15</td>
<td>&lt;10</td>
<td>&gt;15</td>
</tr>
<tr>
<td>Urine ketones*</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
<td>Small</td>
</tr>
<tr>
<td>Serum ketones*</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
<td>Small</td>
</tr>
<tr>
<td>Effective serum osmolality (mOsm/kg)†</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
<td>&gt;320</td>
</tr>
<tr>
<td>Anion gap‡</td>
<td>&gt;10</td>
<td>&gt;12</td>
<td>&gt;12</td>
<td>Variable</td>
</tr>
<tr>
<td>Alteration in sensoria or mental obtundation</td>
<td>Alert</td>
<td>Alert/drowsy</td>
<td>Stupor/coma</td>
<td>Stupor/coma</td>
</tr>
</tbody>
</table>

*Nitroprusside reaction method; †calculation: 2[measured Na (mEq/l)] + glucose (mg/dl)/18; ‡calculation: (Na⁺) – (Cl⁻ + HCO₃⁻) (mEq/l). See text for details.
**TREATMENT**

**IV Fluids**
- Determine hydration status
  - Severe hypovolemia
  - Cardiogenic shock
    - Mild dehydration
      - Administer 0.9 percent NaCl (1.0 L/hr)
      - Evaluate corrected serum Na⁺
        - Serum Na⁺ high
          - 0.45 percent NaCl (250-500 mL/hr) depending on hydration state
        - Serum Na⁺ low
          - 0.9 percent NaCl (250-500 mL/hr) depending on hydration state

**Insulin**
- IV regular insulin
  - Insulin: 0.1 U/kg body weight as IV bolus
  - 0.1 U/kg/hr IV continuous insulin infusion
  - If serum glucose does not fall by 50-70 mg/dL in first hour, double insulin dose
  - When serum glucose reaches 300 mg/dL, reduce regular insulin infusion to 0.05-0.1 U/kg/hr IV. Keep serum glucose between 250 and 300 mg/dL until plasma osmolality is ≤215 mOsm/kg and patient is mentally alert
  - Check electrolytes, BUN, creatinine and glucose every 2-4 hrs until stable. After resolution of HHNS and when patient is able to eat, initiate SC multidose insulin regimen. Continue IV insulin infusion for 1-2 hrs after SC insulin begun to ensure adequate plasma insulin levels. In insulin naive patients, start at 0.5-0.8 U/kg per day and adjust insulin as needed. Look for precipitating cause(s).

**Potassium**
- Establish adequate renal function (urine output ~50 mL/hr)
  - K⁺ <3.3 mEq/L
    - Hold insulin and give 20-30 mEq/K⁺/hr until K⁺ >3.3 mEq/L
  - K⁺ >5.3 mEq/L
    - Do not give K⁺, but check serum K⁺ every two hrs.
    - K⁺ =3.3-5.3 mmEq/L
      - Give 20-30 mEq K⁺ in each liter of IV fluid to keep serum K⁺ between 4-5 mEq/L
Fluid Therapy:

- Typical water deficit of ~100ml/kg
- IV fluids significantly improve hyperglycemia, hypertonicity and metabolic acidosis.
- Fluid of choice= isotonic saline (0.9%NaCl)
  - Infusion rate = 500-1000ml/hour for the first 2 hours
    - Can be reduced thereafter (once BP & tissue perfusion)
Insulin Therapy:

- Uncomplicated DKA- SC Rapid Acting Analogs
  - SC Lispro or insulin aspart every 1-2 hours
    - Initial dose of 0.2-0.3U/kg
    - Thereafter 8-10 units every 2 hours
- Cornerstone of management - critically ill
- Regular insulin via IV
  - IV bolus of 0.1U/kg/hour, follow by continuous infusion of 0.1U/kg/hour
Potassium:
- Total body deficits of ~3-5mEq/kg of body wt
- Despite this, most with DKA have serum numbers at the upper levels of normal
- Insulin & correction of acidosis = stimulation of potassium uptake
- Treatment is to maintain normal potassium levels at 4-5 mEq/l
Bicarbonate:
- Severe metabolic acidosis = impaired myocardial contractility, cerebral vasodilation/coma & several GI complications
- In severe metabolic acidosis - 50 to 100 mmol sodium bicarbonate in 200 ml water every 2 hours until pH rises to ~6.9-7.0.
- Phosphate:
  - Universally deficient in patients with DKA
  - Clinical benefits remain uncertain
**RESOLUTION**

**DKA**
- BG < 200 mg/dl
- Bicarbonate ≥ 18 mEq/l
- pH ≥ 7.3
- Calculated anion gap ≤ 14 mEq/l

**HHS**
- Serum osmolality < 320 mOsm/kg
- BG ≤ 250 mg/dl
- Recovery to mental alertness
For DKA, when switching from IV insulin to SC, basal-bolus using analogs is safer and is preferred over NPH & regular insulin.
COMPLICATIONS OF THERAPY

- Hypoglycemia & Hypokalemia
PREVENTION

- Proper outpatient treatment program
- Patient Education
- Adherence to self-care
Simple Sick Day Guidelines:
- Always take your diabetes medications.
- Drink a glass of sugar free liquid every hour.
- Test your blood sugar more often.
- If your blood sugar is higher than 240, two times in a row, check urine for ketone.
  - You may need to test every 4 hours, if blood sugar is over 240- check during the night.
- Call your doctor if any of these happen:
  - Blood sugar is higher than 300, 2 times within 4 hours
  - You have ketones
  - Vomiting or diarrhea continues for more than 24 hours
  - You are unable to keep down food or drink for more than 4 hours
  - You feel that you need help
- If you can’t eat your regular meal due to N/V, eat or drink 15g of carbohydrate every hour while you are awake.
THANK YOU!