Diabetic Ketoacidosis (DKA): Pathophysiology and Treatment

Diabetic Ketoacidosis is an acute, life-threatening complication of diabetes mellitus characterized by **hyperglycemia** , **ketonemia** , and **metabolic acidosis** . It results from **absolute or relative insulin deficiency** and increased counter-regulatory hormones (glucagon, cortisol, catecholamines, growth hormone), leading to increased lipolysis, ketogenesis, and gluconeogenesis.

Etiology & Risk Factors

Common precipitating events include:

- **Infection** (most common): pneumonia, urinary tract infection
- **Insulin omission or non-compliance**
- **New-onset Type 1 Diabetes Mellitus** (DKA is the presenting symptom in ~25% of cases)
- **Myocardial infarction, stroke, trauma**
- **Pancreatitis**
- **Medications** : corticosteroids, thiazides, sympathomimetics
- **Substance use** : alcohol, cocaine
- **Surgery or other major physiological stressors**

Occurs in:

- **Type 1 Diabetes Mellitus** (most common)
- **Type 2 DM** with severe insulin deficiency (e.g., during stress or illness)

Diagnostic Criteria (ADA)

1. **Hyperglycemia** : Blood glucose > **250 mg/dL**
2. **Ketosis** : Positive serum or urine ketones
3. **Metabolic Acidosis** :
    - Arterial pH < **7.3**
    - Serum bicarbonate < **15 mEq/L**
    - **Anion gap metabolic acidosis** (AG >12)

Note: Severity of DKA is not directly proportional to the level of hyperglycemia.

Clinical Features

Symptoms:

- Polyuria, polydipsia
- Nausea, vomiting
- Abdominal pain
- Generalized weakness and fatigue

- Altered mental status (lethargy ? stupor ? coma)
- Symptoms of underlying illness (e.g., fever, cough)

Signs:

- Dehydration (dry mucosa, hypotension, tachycardia)
- **Kussmaul respiration** (deep, labored breathing)
- **Fruity (acetone) breath odor**
- Abdominal tenderness
- Hypothermia (especially in children)
- Signs of infection or other precipitating causes

Management of DKA

1. Fluid Resuscitation

- Start with **0.9% Normal Saline (NS)** :
  - 15–20 mL/kg/hr for the first 1–2 hours
  - Then adjust to 250–500 mL/hr
- Switch to **0.45% NS** if corrected Na? is normal/high
- When glucose < **200–250 mg/dL** , switch to **D5½NS** to prevent hypoglycemia

Corrected Sodium = Measured Na? + [1.6 x (Glucose - 100)/100]

2. Insulin Therapy

- **Initial IV bolus** : 0.1 unit/kg regular insulin (optional)
- Then **continuous IV infusion** : 0.1 unit/kg/hr
  ? Goal: reduce glucose by 50–70 mg/dL/hr

Do not start insulin if serum K? <3.3 mEq/L ? risk of severe hypokalemia

3. Potassium Replacement

Before insulin, check potassium!

- **K? >5.3** ? no replacement, monitor q2h
- **K? 3.3–5.3** ? add 20–30 mEq KCl per liter of fluid
- **K? <3.3** ? hold insulin, replete potassium first

4. Bicarbonate Therapy *(Controversial)*

- Only if **pH <6.9** or in **severe hyperkalemia with ECG changes**
- Dose: 50–100 mEq sodium bicarbonate over 2 hours

5. Phosphate Replacement

- If phosphate <1 mg/dL or patient has cardiac/muscular dysfunction
- Add **20–30 mEq potassium phosphate** to IV fluids

Transition to Subcutaneous Insulin

- Once patient is eating, hydrated, and **anion gap is closed** :
  - Give **SC basal insulin + meal bolus** 2 hours before stopping IV insulin
  - If insulin-naive: initiate **0.5–0.8 U/kg/day** , divided into basal and prandial components
  - Add **correctional/“sliding scale”** insulin with meals

Complications of DKA

- **Cerebral edema** (esp. in children/adolescents)
  - Presents with headache, confusion, bradycardia, respiratory arrest
  - Treat with **IV mannitol** or **hypertonic saline**
- **Hypophosphatemia**
- **Hypoglycemia** , **hypokalemia**
- **Myocardial infarction**
- **Thromboembolism** (DVT/PE)
- **Cardiac arrhythmias**

Pitfalls & Key Considerations

- **Dilutional hyponatremia** due to hyperglycemia
- **Falsely elevated creatinine** from ketones (interfering with assays)
- **Triglycerides** may cause pseudohyponatremia or affect glucose reading
- Monitor:
  - Blood glucose **hourly**
  - BMP every **2–4 hours**
  - Anion gap and acid-base status

High-Yield Pearls

- DKA is not always hyperglycemic (>250 mg/dL); euglycemic DKA can occur (especially in pregnancy or with SGLT2 inhibitors).
- Treat potassium *before* insulin if K? is low.
- Anion gap closure is the best indicator of DKA resolution.
- Cerebral edema in DKA is a medical emergency—watch for sudden neurological changes after treatment initiation.