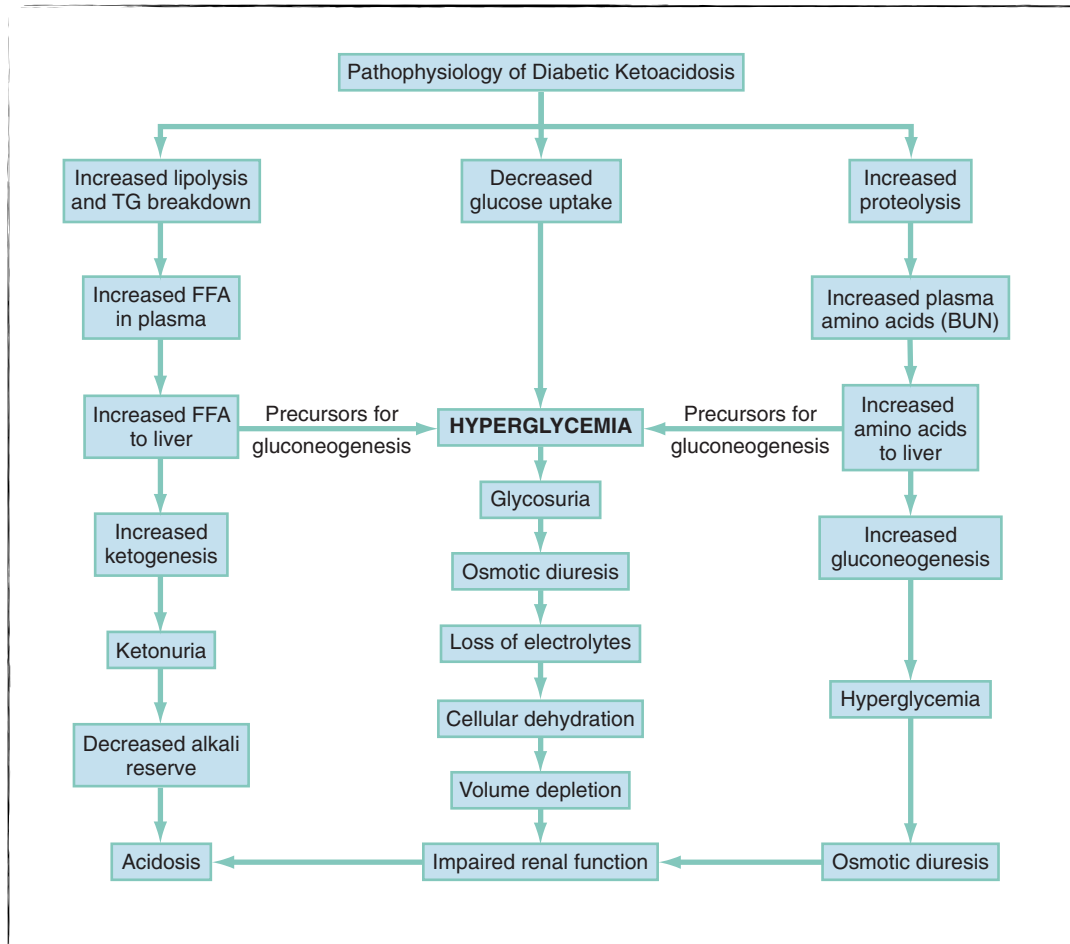


# DIABETIC KETOACIDOSIS

DKA is a syndrome in which insulin deficiency & glucagon excess combine to produce a hyperglycaemic, dehydrated, acidotic patient with profound electrolyte imbalance.



## Important Pathophysiology Points.

- Renal threshold for glucose is surpassed (>10mmol/L)
- Glucose in renal tubules draws *water, sodium, potassium, magnesium, calcium & phosphate* into urine.
  - Marked deficits in these electrolytes may be hidden by dehydration and free water deficits.
- Long-chain FFAs are partially oxidised in the liver to *acetoacetate & beta-hydroxybutyrate*.

## Diagnostic Strategies.

### History.

- Recent onset polydipsia, polyuria, polyphagia.
- Associated weakness, blurred vision, weight-loss, N&V and abdominal pain.
  - Abdominal pain is usually idiopathic.

### Physical Examination.

- Tachypnoea (Kussmaul's breathing).
- Tachycardia, dehydration.
- Hypotension is a late sign.
- Evidence of precipitating illness (?AMI, sepsis etc).

### Laboratory Tests.

- Initial testing will confirm the diagnosis:

#### ***Biochemical Criteria for DKA.***

- Hyperglycaemia;
  - Blood glucose > 11mmol/L (200mg/dL)
- Venous pH < 7.3 or HCO<sub>3</sub><sup>-</sup> < 15mmol/L
- Ketonaemia / ketonuria.

- Serum glucose, FBC, EUC, CMP.
- Blood gas = *raised anion gap, metabolic acidosis.*
- ECG (particularly if no immediate K<sup>+</sup> is available)
- Urine.
- Ketone levels (point of care, urine, serum).
- Cultures.

#### *A word on Sodium...*

Misleading in hyperglycaemia. Strongly affected by glucose, triglycerides & insensible losses...

#### **Corrected Sodium:**

$$= \text{measured sodium} + [\text{glucose}/3]$$

#### *Correcting Potassium for Acidosis*

can be corrected by subtracting 0.6 mmol/L from the measured K<sup>+</sup> value for every 0.1 decrease in pH....

eg. serum K = 5mmol/L w/ pH 6.90 (ie. 0.5 less than 7.4)

$$\begin{aligned} \text{corrected K}^+ &= 5\text{mmol/L} - [0.6 \times 5] \\ &= 5 - 3 \\ &= 2\text{mmol/L.} \end{aligned}$$

### Differential Considerations.

- Alcoholic vs starvation ketoacidosis.
  - Alcohol > 20% all ketoacidoses.
- Can develop in 3rd trimester of pregnancy (or nursing mothers who do not eat).
- Recall your other causes of raised anion-gap metabolic acidosis (particularly the toxic alcohols & salicylates).
- Hyperglycaemia without ketones = consider HHS (HONK).

## Management.

### General Measures.

- The approach to the patient w/ severe DKA is the same as any patient in extremis.
- ABCD approach.
- Obtunded & vomiting, requires airway protection.
- If you intubate; you must *match the patients minute ventilation* to avoid relative respiratory acidosis.
- Hypovolaemic shock requires aggressive fluid resuscitation.
- Identify & treat the precipitating illness.

### Insulin.

- DKA cannot be reversed without insulin.
- Low-dose therapy is preferable (no boluses !!)
  - 0.1 units/kg/hr via IV infusion.
- Dextrose is added to IV fluids once glucose levels reach 15mmol/L.
- Insulin infusion requires *priming of the tubing and burettes* to avoid insulin adhering to their walls.

### Dehydration.

- Patients may have fluid deficit of > 3-5L.
- Fluid boluses are acceptable if patient is in shocked state.
- Target:
  - 1st litre over 1st hour.
  - 2nd litre over 4 hours.
- Fluid therapy alone will reduce serum glucose levels (by ~ 18%).

### Potassium.

- Replacement is needed for all DKA patients.
- Levels will plummet with correction of acidosis and insulin administration.
- 20-40mmol/L in replacement fluid is req'd.

### Magnesium.

- Deficiency is a common problem in DKA.
- Deficiency promotes hypokalaemia.
- May need up to 0.3mmol/kg replacement.
  - 1-3grams in a 70kg patient.

### Acidosis.

- Acidosis will correct with fluids and insulin.
- Bicarbonate is rarely indicated & worsens intracellular acidosis.
- If bicarb is deemed necessary, pH should not be corrected beyond 7.1

#### **BOX 124-7** SUMMARY OF TREATMENT FOR DIABETIC KETOACIDOSIS

Identify DKA: serum glucose, electrolytes, ketones, and ABG; also draw CBC with differential; urinalysis; chest radiograph film and ECG, if indicated.

1. Supplement insulin.
  - ± Bolus: 0.1 U/kg regular insulin IV
  - Maintenance: 0.1 U/kg regular insulin IV
  - Change IV solution to D<sub>5</sub>W 0.45% NS when glucose ≤ 300 mg/dL.
2. Rehydrate.
  - 1–2 L NS IV over 1–3 hours
  - Children: 20 mL/kg NS over first hour
  - Follow with 0.45% NS
3. Correct electrolyte abnormalities.
  - Sodium
    - Correct with administration of NS and 0.45% NS.
  - Potassium
    - Ensure adequate renal function.
    - Add 20–40 mEq KCl to each liter of fluid.
  - Phosphorus
    - Usually unnecessary to replenish
  - Magnesium
    - Correct with 1–2 g MgSO<sub>4</sub> (in first 2 L if magnesium is low).
4. Correct acidosis.
  - Add 44–88 mEq/L to first liter of IV fluids only if pH ≤ 7.0.
  - Correct to pH 7.1.
5. Search for and correct underlying precipitant.
6. Monitor progress and keep meticulous flow sheets.
  - Vital signs
  - Fluid intake and urine output
  - Serum glucose, K<sup>+</sup>, Cl<sup>-</sup>, HCO<sub>3</sub><sup>-</sup>, CO<sub>2</sub>, pH
  - Amount of insulin administered
7. Admit to hospital or intensive care unit.
  - Consider outpatient therapy in children with reliable caretaker *and*
  - Initial pH > 7.35
  - Initial HCO<sub>3</sub><sup>-</sup> ≥ 20 mEq/L
  - Can tolerate PO fluids
  - Resolution of symptoms after treatment in emergency department
  - No underlying precipitant requiring hospitalization

## **Complications of DKA.**

Morbidity from DKA is largely iatrogenic.

- Hypokalaemia
- Hypoglycaemia
- Alkalosis (aggressive bicarbonate therapy)
- CCF
- Cerebral oedema

Poor prognostic signs in DKA:

- Hypotension
- Azotaemia
- Coma
- Underlying illness.

Primary Causes of Death in DKA:

- Infection (especially pneumonia)
- Arterial thromboses
- Shock

## **Disposition.**

Most patients w/ DKA require hospital admission (and occasionally ICU).

<b>Table 220-1 Important Causes of Diabetic Ketoacidosis</b>
Omission or reduced daily insulin injections
Dislodgement/occlusion of insulin pump catheter
Infection
Pregnancy
Hyperthyroidism
Substance abuse (cocaine)
Medications: steroids, thiazides, antipsychotics, sympathomimetics
Heat-related illness
Cerebrovascular accident
GI hemorrhage
Myocardial infarction
Pulmonary embolism
Pancreatitis
Major trauma
Surgery