# Diabetes I - Ketoacidosis

Treatment – Swedish recommendations

CME 20th of April 2023 in the Kwanza Sub-County Hospital

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# Background

- Diabetes I - absolute or relative underproduction of insulin. A situation with intracellular starvation.
- Diabetic ketoacidosis (DKA) exists by definition when:

  P-Glucose ≥ 11 mmol/L  AND  B-Ketone ≥ 3 mmol/L  AND  pH ≤ 7,3
- Severe acidosis with coma can develop quickly and already at P-Glucose 11-15 mmol/L. Mortality is 0.5-10%. Often severe dehydration.
- Severity of DKA:
  - Mild: pH 7.25-7.3
  - Moderate: pH 7.0-7.24
  - Severe: pH < 7.0
- Causes DKA: infections, myocardial infarction, cerebrovascular events, new onset of diabetes type 1, improper handling of insulin.

# Background

Symptoms develop over hours to days

<u>Early symptoms</u>

- Increased urine output
- Increased thirst
- Dry mouth

<u>Later symptoms</u>

- Impotence
- Stomach ache
- Shortness of breath with Kussmaul breathing
- Nausea/vomiting
- Decreased consciousness, coma

# Treatment - Fluid

In case of high P-Glucose with nausea and/or vomiting, blood gas (arterial or venous) must be taken to evaluate the degree of ketoacidosis or B-ketones.

In one arm: i.v. line for fluid and potassium (K)

In other arm: i.v. line for insulin

**1. Fluid - First priority!**

- First hour: 1 liter NaCl 0.9%
- For 2 hours: 1 liter Ringer acetate
- For 8 hours: 2 liter Ringer acetate

**All these patients are dehydrated, often 4-6 liters, and always potassium deficient, even if S-K is elevated.** (Intracellular K ≠ S-K)

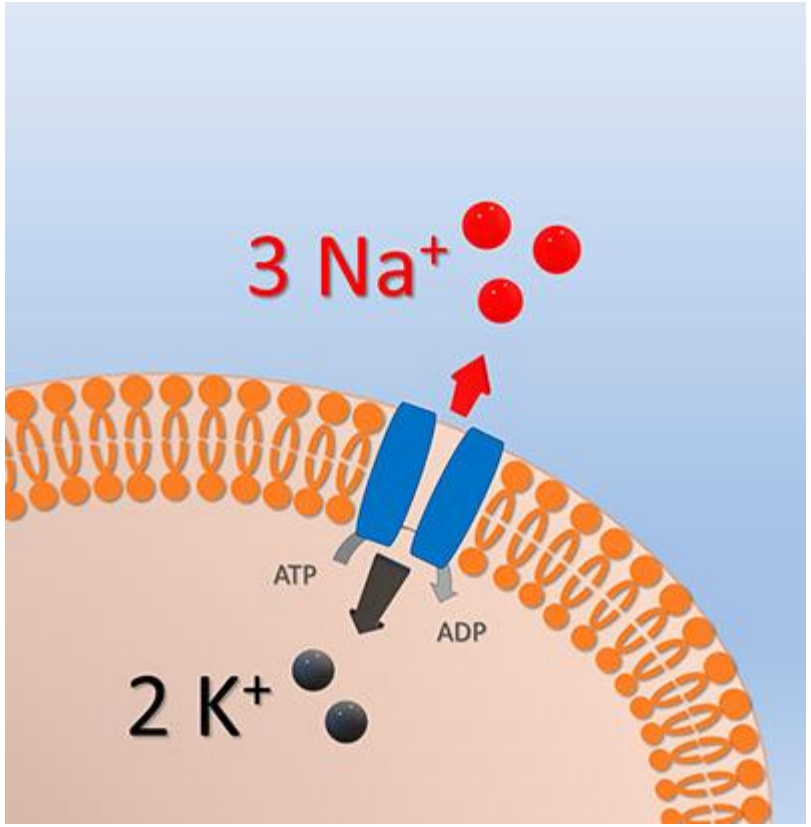
# Treatment - Insulin

## 2. Insulin

- The goal is to reduce P-glucose by 4 mmol/L per hour.
- Rapid-acting insulin via pump at 0.1 E/h/kg. Add 100 E of rapid-acting insulin to 500 mL of 0.9% NaCl (= 0.2 E/ml).
- P-Glucose every hour.
- When P-Glucose is below 15 mmol/L glucose is added.

# Treatment – Potassium (K)

- Displacement of potassium ions from the intracellular to the extracellular space takes place via various ion channels.
- In acidosis, potassium is moved out of the cells as Na/K-ATPase is pH-dependent.
- Insulin deficiency leads to hyperkalemia as insulin activates the Na/K-ATPase.
- In hyperglycemia water and potassium ions are transported extracellularly due to osmosis.




**A normal potassium value in acidosis indicates an actual potassium intracellular deficiency.**

# Treatment – Potassium (K)

### 3. Potassium

- In acidosis - always a **relative lack of potassium**. Hypokalaemia must be prevented.
- Potassium is added when S-K below 5.2 mmol/L with 10 mmol K/h.
- Check S-K every 1-2 hours.
- Goal S-K 4-5 mmol/L.
- If S-K is below 3.3 mmol/L, potassium substitution must be prioritized.
- Insulin may only be given after S-K is above 3.6 mmol/L. Otherwise there is a risk of continued falling S-K with life-threatening arrhythmias. If S-K below 3.0 mmol/L: case for intensive care and telemetry monitoring.

# Treatment (cont.)

**4. Buffer**

- Rarely needs to be given.
- S-Potassium drops by 0.6 mmol/L for every pH increase of 0.1.

**5. Glucose**

- Stop insulin infusion when P-glucose is below 15 mmol/L.
- Start infusion with 500 mL of Glucose 10% (100 mg/mL) added with 20 E of fast-acting insulin at 100 mL/hour.
- Treatment is given until B-ketones are normalized.

# Outside hospital – first line treatment

**1. Fluid - First priority!**

- Follow vital parameters – general condition, respiratory rate, saturation, pulse, blood pressure, urine production.
- Give oxygen if necessary.
- Insert i.v. needle.
- Give NaCl 0.9% i.v.
- Contact/transport to higher level facility.
- Do not give insulin.

How to treat DKA in a low-resource medicine setting, e.g. without possibility to monitor electrolytes and no immediate possibility to refer to higher level facility?

**1. Fluid - First priority!**

**2. Insulin?** **3. Potassium?**

*One study shows that administration of IM regular insulin was effective in reducing the BG to < 250 mg/dL (15 mmol/L) in patients with DKA. The mean amount of insulin required for correction of acidosis was 72.3 units and the mean time to achieve this was 33 h.*

There are, however, no recommendations found for treating with insulin without access to:

- Monitoring P-Glu, S-K, S-Ketone, pH
- i.v. electrolyte correction with Potassium (K)

# What if you only have access to fluid, insulin and P-glu and no possibility to check electrolytes or to refer?

?

Fluids: NaCl 0.9%, Ringer
No insulin

- Only temporary treatment.
- Lethal, but allows for a delay before further treatment.

Fluid: NaCl 0.9%, Ringer
IM insulin (+ potassium) in low dosages, 0.1E/kg
Goal: P-glu 10-15 mmol/L
Monitor clinical symptoms

Might work with mild DKA.
Extremely dangerous otherwise,
but could save lives…
(no studies done)

# Improvements

Avoiding DKA at community level

- Education: How to avoid (diabetes I), early signs
- Access to insulin: Availability, cost

Capability to handle DKA at local medical level

- Access to fluids, insulin, potassium
- Access to monitoring P-glu, S-K, B-ketone, pH
- Competence to diagnose
- Routine for referral

References:


- Management of diabetic ketosis and ketoacidosis with intramuscular regular insulin in a low-resource family medicine setting. J Family Med Prim Care. 2017 Jan-Mar; 6(1): 25–28
- The management of diabetic ketoacidosis at a rural regional hospital in KwaZulu-Natal. Afr J Prim Health Care Fam Med. 2018; 10(1): 1612
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- Diabetic Ketoacidosis Management: Updates and Challenges for Specific Patient Population. Endocrines 2022, 3(4), 801-812