Case Study
Diabetic Ketoacidosis
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A 43-year-old gentleman with a long history of type 2 diabetes (> 6 years), dyslipidemia and hypertension presented to the emergency department with a 6-day history of weakness, fever, nausea, vomiting and a painful left foot with foul smelling pus discharge from ulcer on the sole.

He was on gliclazide and metformin since diagnosis. Mixtard 30 units bd was started 1 year ago because of poor glycaemic control.

Stopped injecting insulin for 1 week ago – poor appetite precipitated hypoglycaemia.
Examination

Temperature 38.9°C
BP 96/60 mmHg, Pulse 136 beats/minute, low volume
Respiration 36 breaths/minute, deep sighing breathing

Drowsy but arousable.
Tongue coated, dry mucosa and decrease skin turgor

Lungs clear; Heart sounds normal.
The abdominal exam - mild epigastric tenderness to deep palpation; no rebound tenderness or guarding.
Left foot suppurative ulcer with adjacent cellulitis extending to the knee.

Capillary blood glucose: 28 mmol/L
Laboratory Results

Urinalysis:
• Glucose 4+, ketones 3+, nitrite and leucocyte negative

Venous blood gas:
• pH of 7.06, pCO$_2$ 17 mmHg, bicarbonate 5.6 mmol/L

Blood glucose: 30 mmol/L

Blood lactate: 3.2 mmol/L (0.5 – 1.0 mmol/L)

Renal profile:
• Urea 12 mmol/L, sodium 142 mmol/L, potassium 5.0 mmol/L, chloride of 112 mmol/L, creatinine 136 μmol/L

FBC:
• Leucocyte 23 x 10$^9$/L with predominant neutrophils, haematocrit 55%
Imaging

Chest X-ray: unremarkable

X-ray left foot:
• Diabetic foot with osteomyelitic changes of 1-3 metatarsals.
More tests?

**Serum osmolality**

- Formula: \((2 \times \text{serum } [\text{Na}]) + \text{[glucose]} + \text{[urea]}\) (all in mmol/L)
- Or laboratory measured value

\[
(2 \times [142]) + [30] + [12] = 326
\]

Normal range 275-295 mosmol/kg

**Anion gap**

\[
([\text{Na}^+] + [\text{K}^+] - ([\text{Cl}^-] + [\text{HCO}_3^-]))
\]

\[
(142 + 5) - (112 + 5.6) = 29.4
\]

Normal range 8 – 16 mmol/L

**Others**

- **Septic workup**
  - Pus – for culture and sensitivity
  - Blood cultures

- **ECG**
What is the diagnosis?

<table>
<thead>
<tr>
<th>This patient</th>
<th>Criteria for diabetic ketoacidosis</th>
<th>Diagnosis</th>
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</table>
| • Blood glucose 30 mmol/L  
• Urine ketones 3+  
• Bicarbonate 5.6 mmol/L | • Capillary blood glucose >11 mmol/L  
• Capillary ketones >3 mmol/L or urine ketones ≥2+  
• Venous pH <7.3 and/or bicarbonate <15 mmol/L | • Diabetic ketoacidosis |
### What are the precipitating factors?

**Precipitating factors**
- Infection
- Missed insulin therapy
- Acute coronary syndrome
- CVA
- Surgery

**This patient**
- Infection of left foot
- Missed insulin therapy
What happen if treatment is delayed?

- High mortality rate:
  - Overall mortality is <1%
  - Mortality rate >5% in the elderly
Prognosis

• Excellent with prompt treatment
• High-dependency unit (HDU) care
What is the immediate management?

1st hour
- Commence 0.9% saline drip - large bore cannula.
- Commence fixed rate intravenous insulin infusion (0.1 unit/kg/hr).
- Assess patient:
  - Investigations
  - Monitoring regime
  - Look for precipitating causes and treat accordingly – infected foot ulcer and cellulitis

2nd - 6th hour
- Reassess patient, monitor vital signs
- Continue fluid replacement via infusion pump
- Assess response to treatment
- Additional measures: fluid balance chart; urinary catheterisation if anuric; nil by mouth and NG tube, ABG, ECG monitoring if indicated

6th - 12th Hour
- Reassess patient, monitor vital signs (reduce fluid; K balance; blood glucose < 14 mmol/l – D5% infusion)
- Reassess cardiovascular status at 12 hours; further fluid may be required; Check for fluid overload
- Review biochemical and metabolic parameters: check for resolution of DKA; referral to diabetes team

12-24 hours
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Aims of treatment:
- Rate of fall of ketones of at least 0.5 mmol/L/hr, or
- Bicarbonate rise 3 mmol/L/hr, and
- Blood glucose fall 3 mmol/L/hr
- Maintain serum potassium in normal range
- Avoid hypoglycaemia

6th - 12th Hour
Aims:
- Ensure clinical and biochemical parameters improving
  - Continue IV fluid replacement
  - Avoid hypoglycaemia
  - Assess for complications of treatment e.g. fluid overload, cerebral oedema
  - Treat precipitating factors as necessary

12-24 hours
Aims:
- Ensure that clinical and biochemical parameters are continuing to improve or are normal
  - Continue IV fluid replacement if not eating and drinking
  - If ketonaemia cleared and patient is not eating and drinking, titrate insulin infusion rate accordingly
  - Reassess for complications of treatment e.g. fluid overload, cerebral oedema
  - Continue to treat precipitating factors
  - Change to subcutaneous insulin if patient is eating and drinking normally
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Resolution of DKA
- Blood ketones < 0.3 mmol/L,
- Venous pH > 7.3 (do not use bicarbonate as a surrogate at this stage)

If DKA not resolved review insulin infusion
- Fluid overload, cerebral oedema
- Treat precipitating factors as necessary

- Avoid hypoglycaemia