MANAGEMENT OF DIABETIC KETOACIDOSIS

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Diagnosis

- elevated plasma and/or urinary ketones
- metabolic acidosis (raised H^+/low serum bicarbonate)

Remember that hyperglycaemia, although usually marked, is not a reliable guide to the severity of acidosis, and in children, pregnant women, malnourished or alcoholic patients, blood glucose may not be very raised.

The degree of hyperglycaemia is not a reliable guide to the severity of the metabolic disturbance in DKA.

The presence of the following features should alert you to the possibility of DKA:

- intra and extra-vascular volume depletion with reduced skin turgor, tachycardia and hypotension (late features)
- rapid and deep sighing respirations, smell of ketones
- ketonuria
- vomiting/abdominal pain
- drowsiness/reduced conscious level

Consider DKA in any unconscious or hyperventilating patient.

Remember:

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- Patients with adverse clinical signs (on the SEWS chart) or signs of cerebral oedema (see below) should be discussed immediately with senior medical staff.
- These guidelines refer to adult patients. All patients under the age of 16 should be discussed with the paediatric diabetes team at the Sick Children's hospital and arrangements made for transfer when clinically appropriate.

Immediate management – Within the First Hour

Initial Assessment

- Airway and breathing - correct hypoxaemia.
- IV access.
- monitor ECG, O_2 saturations, pulse, BP, respiratory rate, conscious level and fluid balance.
- Laboratory blood glucose, bedside BM, urea and electrolytes, serum bicarbonate, arterial blood gases.

Fluid Replacement

- Commence rehydration with 0.9% saline 1000 ml over one hour.

Intravenous Insulin

- Prepare intravenous insulin infusion (see below) and commence at 3 units/hr

Other Interventions/Actions

- NG tube if impaired consciousness or protracted vomiting.
- Catheter if oliguric.
- Consider central line if clinically indicated.
- Admits patient to a high dependency area.
- **Call the metabolic/diabetes registrar.**

Ongoing management – Hours 2 - 4

Reassess patient regularly and monitor vital signs

Intravenous fluids

- Aim to rapidly restore circulating volume and then gradually correct interstitial and intracellular fluid deficits.
- Use isotonic saline (see example below) – infusion rates will vary between patients, remember risk of cardiac failure in elderly patients.
- If hypotension (SBP < 100 mmHg) or signs of poor organ perfusion are present, use colloid to restore circulating volume.
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1000mls 0.9% saline over 2nd hour

500mls 0.9% saline over 3rd hour

500mls 0.9% saline over 4th hour

- Add in 10% dextrose once blood glucose ≤14 mmol/l. Infuse at 100mls/hr. **Do not alternate saline and dextrose.** Measure U&Es and *venous* bicarbonate at the end of hour 2 and hour 4.

Electrolyte replacement

- Despite a considerable total body potassium deficit (300 – 1000 mmol/l), plasma potassium levels are usually normal or high at presentation, because of acidosis, insulin deficiency and renal impairment.
- Potassium concentration **will** fall following commencement of treatment; expect to give plenty of potassium.
- Target potassium concentration is 4.0-5.0 mmol/l.

Severe hypokalaemia complicating treatment of DKA is potentially fatal and is usually avoidable.

Blood Glucose and Insulin

- Hourly *laboratory* glucose
- Aim to ensure a gradual reduction in blood glucose over the first 12-24 hours. There is no specific evidence to avoid rapid rates of fall (e.g. >5mmol/hr), but there are some observational data to suggest that excessive rates of fall may be associated with cerebral oedema.
- The target blood glucose concentration for the end of the first day is 10-20mmol/l.
- Make up an infusion of 50 units of soluble insulin (e.g. Humulin S or Actrapid) in 50 mls 0.9% saline (1 unit/ml) and infuse using a syringe driver.

Aim for a gradual reduction in blood glucose over 12 hours

- 6 units/hr initially
- 3 - 4 units/hr when blood glucose < 14 mmol/l

If plasma glucose does not fall in the first hour, the rate of infusion needs increased - **phone the metabolic registrar and/or senior medical staff for advice**

- If blood glucose falls below target (i.e. <9mmol/l) on 3 units/hr, reduce insulin infusion to 2 units/hr. **Do not reduce the insulin rate below this.** If glucose continues to fall, increase the infusion rate of dextrose or the concentration. Discuss with the diabetes registrar and/or senior medical staff.
- Remember that intravenous insulin has a half-life of 2.5 minutes. It is important that the insulin infusion is not interrupted.

Consider Precipitating Factors

If indicated check:

- FBC
- CXR
- ECG
- Urine gram stain and culture
- Blood cultures and other infection screen

Correction of acidosis

- Volume resuscitation and insulin infusion will correct metabolic acidosis in the majority.
- Ketonaemia typically takes longer to clear than hyperglycaemia.
- Intravenous sodium bicarbonate should not be used routinely and certainly not without discussing with a senior doctor (there is evidence it may cause harm if there is evidence of cardiogenic shock or other lactate-generating conditions).

Other measures

- Urinary catheter: if cardiac failure, persistent hypotension, renal failure or no urine passed after 2 hours.
- CVP line: consider if elderly with concomitant illness, cardiac failure or renal failure.
- Give standard venous thromboembolism prophylaxis.
- Antibiotics: only if infection is proven or strongly suspected. Remember that raised WBC and fever occur with metabolic acidosis.
- Screen for myocardial infarction if > 40 years old

Subsequent Management – 4 hours+

Fluids and Electrolytes

- Allow oral intake if swallowing safe and bowel sounds present.

- Measure U&Es and venous bicarbonate twice daily, until bicarbonate within the normal reference range.
- Continue with 0.9% saline ≤250ml/hour until bicarbonate is in the reference range and the patient is eating.
- Continue potassium infusion until target is maintained.

Insulin and Dextrose

- A blood glucose meter can be used to monitor blood glucose concentration if the previous laboratory blood glucose is <20mmol/l.
- Pre-meal subcutaneous insulin should be administered to patients who are eating, even when on intravenous insulin. Discuss the doses with the diabetes registrar.
- Maintain IV insulin (minimum rate 2 units/her) and 10% dextrose infusion (100ml/hr) until biochemically stable and patient has eaten at least two meals. In such circumstances, stop IV insulin 30 minutes after subcutaneous insulin.

Continuing Care

- Ensure patient is reviewed by the diabetes team on the day following admission (at the very latest), so that the cause of the DKA can be elucidated, appropriate education can be given and follow up arranged.
- Patient should not be discharged until biochemically normal, eating normally and established on subcutaneous insulin.
- Ensure that a copy of the discharge summary is sent to the diabetes team.

Acute complications

- Hypokalaemia: due to inadequate potassium replacement and predictable due to insulin and fluid administration and resolution of acidosis. Avoid by regular monitoring of electrolytes and appropriate potassium replacement.
- Hypoglycaemia: due to overzealous treatment with insulin.
- Hyperglycaemia: due to interruption or discontinuance of intravenous insulin after recovery without subsequent coverage by subcutaneous insulin – **always ask advice of metabolic registrar.**
- Cerebral oedema: rare but potentially fatal. More common in children, but is seen in young adults. Characteristically, the patient has initially responded well to treatment prior to the development of severe headache and neurological deterioration. **Get urgent senior help.** Treatment is with mannitol 0.5 – 2-g/kg body weight.
- ARDS: suspect if dyspnoea, tachypnoea, central cyanosis and non-specific chest signs. Manage on ITU.
- Thromboembolism – presentation and management as standard.

Potassium replacement

No potassium in the first litre unless known to be < 3.0 mmol/l

Thereafter, replace potassium as below:

plasma potassium (mmol/l)	potassium added (mmol/hr)
< 3.5	40*
3.5 – 5.0	20
>5.0, or anuric	No supplements

* must be given in one litre of fluid; avoid infusion rates of KCL >10 mmol/hr

Protocol prepared by Vincent McAulay 10/2002
Updated by Mark Strachan 5/2004