

MANAGEMENT OF DIABETIC KETOACIDOSIS

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.

i 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 feature).
- Rapid and deep sighing respirations, smell of ketones.
- Ketonuria
- Vomiting/abdominal pain.
- Drowsiness/reduced conscious level.

Remember:

- Consider DKA in any unconscious or hyperventilating patient.
- 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.

RIE/WGH/SJH have an integrated care pathway which should be adhered to. The following is the RIE/WGH protocol. The SJH protocol differs slightly.

IMMEDIATE MANAGEMENT - WITHIN THE FIRST HOUR

Initial Assessment and Treatment

- Airway and breathing - correct hypoxaemia.
- IV access.

- Monitor respiratory rate, ECG, O₂ saturations, pulse rate, BP, respiratory rate, conscious level and fluid balance.
- Perform laboratory blood glucose, bedside BM, urea and electrolytes, serum bicarbonate, arterial blood gases.

Fluid Replacement

- Commence fluid therapy with 0.9% saline 1 litre over 1 hour. A specimen IV fluid regime is shown below.

Intravenous Insulin

- Prepare intravenous insulin infusion ([see below](#)) and commence at 6 units/hr.

Other Interventions/Actions

- 12 lead ECG
- NG tube if impaired consciousness or protracted vomiting.
- Urinary catheter if oliguric.
- Admit patient to a high dependency area.
- Consider need for central line if clinically indicated.
- **Call the diabetes registrar and/or senior medical staff.**

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 <100mmHg) or signs of poor organ perfusion are present, use colloid to restore circulating volume.

1000mls 0.9% NaCl over 2nd hour
500 mls 0.9% NaCl over 3rd hour
500 mls 0.9% NaCl over 4th hour

- Add in 10% dextrose once blood glucose ≤ 14 mmol/l. Infuse at 100 mls/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 have to give plenty of potassium.
- Target potassium concentration is 4.0-5.0mmol/l.



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

Potassium Replacement

No potassium in the first litre unless known to be < 3.0 mmol/l. Thereafter, replace potassium as below:

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

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

- Occasionally infusion rates of over 10mmol/hr may be required. If so senior medical staff should decide this and ECG monitoring is mandatory.
- 40mmol of potassium should be diluted in 1 litre of fluid if given by peripheral cannula. *Use pre-prepared bags with KCl.*

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 9-14 mmol/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.

Rate of Insulin Infusion

- 6 units/hr initially.
- 3 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 diabetes registrar and/or senior medical staff for advice.**

- If blood glucose falls below target (i.e. <9 mmol/l) on 3 units/hr, reduce insulin infusion to 2 units/hr. **Do not reduce the insulin infusion 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 dipstick for leucocytes and nitrites and culture (urgent lab microscopy is not necessary)
- 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 (no evidence that it is effective).

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 according to local protocols: but first exclude coagulopathy.
- 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 ≤ 250 ml/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 <20 mmol/l.
- Pre-meal subcutaneous soluble insulin should be administered to patients who are eating, even when on intravenous insulin. Discuss the doses with the diabetes team.
- Maintain IV insulin (minimum rate 2 units/hr) 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 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 OF DKA

- 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 over treatment with insulin.
- Hyperglycaemia: due to interruption or discontinuation of

intravenous insulin after recovery without subsequent coverage by subcutaneous insulin - **always ask advice of diabetes team.**

- 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: call ICU.** Treatment depends on clinical state and includes mannitol 0.5 - 2 g/kg body weight.
- ARDS: suspect if dyspnoea, tachypnoea, central cyanosis and non-specific chest signs. Manage ABCDE and call ICU.
- Thromboembolism - prevention and management as standard.

MANAGEMENT OF DIABETIC HYPEROSMOLAR NON-KETOTIC SYNDROME

- Common in frail elderly.
- High mortality (30%).
- May be previously undiagnosed diabetes, but can also develop in people with known type 2 diabetes.
- Significant hyperglycaemia: ketonuria and acidosis are usually absent.
- Acute intercurrent illness is common.

DIAGNOSIS

Typical features include:

- Severe hyperglycaemia (>50 mmol/l).
- Hyperosmolarity (>320 mosmol/kg) with profound dehydration and prerenal uraemia.
- Depression of the level of consciousness; coma is well recognised.

Plasma osmolality

$2 \times (\text{Na} + \text{K}) + \text{urea} + \text{glucose}$ (all mmol/l)
normal range is 280 – 300 mosmol/kg

IMMEDIATE MANAGEMENT - WITHIN THE FIRST HOUR

Initial Assessment

- Airway and breathing ensure airway and correct hypoxaemia.
- IV access.

- Monitor respiratory rate, ECG, O₂ saturations, pulse rate, BP, 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

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

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 serum sodium exceeds 155mmol/l, use 0.45% saline instead of isotonic. **Discuss with diabetes registrar/senior medical staff.**

500 mls saline over 2nd hour

500 mls saline over 3rd hour

500 mls saline over 4th hour

- If hypotension (SBP <100 mmHg) or signs of poor organ perfusion are present, use colloid to restore circulating volume.
- Add in 10% dextrose once blood glucose \leq 15mmol/l. Infuse at 125-250 mls/hr. **Do not alternate saline and dextrose.**
- Measure U&Es and serum osmolality at the end of hour 2 and hour 4.