

Protocol for the Acute Management of Diabetic Ketoacidosis in **Adults**¹

Definition: Severe uncontrolled diabetes with: (a) ketonaemia/ketonuria; (b) metabolic acidosis (pH <7.35, bicarbonate <15); (c) usually with hyperglycaemia

SYMPTOMS AND SIGNS: Hyperventilation Dehydration Abdominal Pain Impaired Consciousness

KEY ISSUES: Initial Fluid Replacement Insulin Potassium Replacement Good Monitoring

Warning² : This condition carries a high mortality rate. Close monitoring in a medical high dependency setting is essential. If there is a suspicion of cerebral oedema³ or the patient is not improving within 4 hours of admission, immediate senior review is necessary. (Signs of cerebral oedema include headaches and reduced conscious level.)
Time is paramount: SEWS must be recorded hourly for the first 4 hours and frequently thereafter.

First Name _____
Family Name _____
CHI
Address: _____
(Patient label if available)

Please once each task has been carried out:

STAGE 1: IMMEDIATE MANAGEMENT On presentation & within the first hour:

STEP 1: Initial Actions

- IV cannula.....
- Immediate saline 0.9%⁴, 1000ml/hour.....
- U&Es, blood glucose (BG), venous gases.....
- Urinary/blood ketones⁵.....
- Other bloods (FBC, Cultures etc).....

-STEP 2: Start Insulin⁶

- Soluble (Actrapid etc.), 6 units/hour IV.....
(Should be prescribed on infusion chart using pre-prepared DKA label)

-STEP 3: Other Actions⁷

- Fluid balance chart.....
- Monitor conscious level.....
- Cardiac monitoring.....
- Nasogastric tube if protracted vomiting and/or unprotected airway.....
- Consider central line⁸.....
- Consider antibiotics if true signs of sepsis⁹.....

¹⁻¹⁵ Supplementary notes giving further guidance are provided overleaf

Adapted for Tayside from the Scottish Diabetes Group Protocol by Grant Franklin, Debbie Voigt & Dan Cuthbertson
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STAGE 2: ON-GOING MANAGEMENT

Second, third & fourth hour:

STEP 1: Re-assess Patient, Monitor SEWS hourly and watch for headache

- Catheter if oliguric (or evidence of renal or cardiac failure).....
- Continue saline 0.9%
 - Hour 2 1000ml/hr.....
 - Hour 3 500ml/hr.....
 - Hour 4 500ml/hr.....

- Add potassium to saline, unless anuric or k⁺ remains >5.0¹⁰:
 - Plasma potassium 3.5 – 5 mmol/L: 20mmol with each litre of saline (ie 20mmol every second 500ml bag).....
 - Plasma potassium < 3.5 mmol/L: 40mmol with each litre of saline (ie 20mmol in each 500ml bag).....
- Add in additional 10% dextrose 100ml/hour when BG ≤14mmol/L^{11,12}, (second cannula needed).....

-STEP 2: Further Monitoring, Continuation of Insulin

- Hourly fingerprick blood glucose^{13,14}:
 - Hour 2 Hour 3 Hour 4
- Continue insulin 6 units/hour until BG ≤14mmol/L then 3 units/hour (or rate to maintain BG 9-14).....
- U&Es, lab. glucose & bicarbonate (or venous gas) at end of Hours 2 & 4 : Hour 2 Hour 4
- Blood/urine ketone measurement at end of hour 4.....

-STEP 3: Consider Precipitating Factors¹⁵

- If indicated (and not done previously) check:
 - CXR ECG MSSU

Date of admission / / 20 Time

STAGE 3: SUBSEQUENT MANAGEMENT

STEP 1: Re-assess Patient, Monitor SEWS and watch for headache.

- Allow oral intake if bowel sounds present.....
- Measure bicarbonate twice daily until within reference range.....
- Monitor blood/urine ketones 4 hourly until undetectable.....
- Continue 10% dextrose, 100ml/hour to maintain BG, in conjunction with saline 0.9% ≤250ml/hour until bicarbonate in reference range and patient is eating.....
- Continue potassium (approx. 20mmol for each litre fluid in total) to maintain within reference range and continue to monitor twice daily.....

STEP 2: Continuation of Insulin¹⁰

- Continue to measure BG hourly.....
- Insulin 3 units/hr (or rate to keep BG 9-14).....
- Convert back to usual subcutaneous insulin when biochemically stable and eating.....
- Stop IV fluids and insulin 30 minutes after subcutaneous insulin.....

**REFER FOR SPECIALIST
REVIEW BEFORE DISCHARGE**

1. This protocol is for the acute management of diabetic ketoacidosis in patients 16 years and over. Patients presenting in DKA below the age of 16 should be referred to the paediatric team. (Note: this is locally agreed policy with the paediatric department) Paediatric Management Guidance is available from:

<http://www.bsped.org.uk>

If in doubt as to the age category of the patient, call the duty paediatrician.

2. Warning: Due to the significant mortality that this condition carries, management should be in a **high dependency environment**. The following clinical signs indicate the need for close monitoring, and should be discussed with senior team members.

- Respiratory rate >20/min
 - Pulse >90/min
 - Systolic BP <100mmHg
 - Circulatory compromise - pale, sweaty, cool or clammy peripheries - mottling indicates severe circulatory compromise
 - Temp >38°C or <36°C
 - GCS <8 (This may indicate cerebral oedema, particularly in younger patients, and requires senior assessment).
- It is recognised that there will not always be an HDU bed available. In this case, medical and nursing staff must ensure the patient is appropriately monitored until an HDU bed can be arranged or clinical improvement occurs.

3. Signs of Cerebral Oedema

Children and adolescents are at the highest risk of cerebral oedema. It may present with headaches, reduced conscious level or focal deficits.

How to take action

- Administer IV mannitol (100mls of 20% over 20 minutes) and/or dexamethasone 8mg (discuss with Consultant)
- Undertake CT scan to confirm findings
- Refer to ITU

4. Fluid replacement should commence as soon as possible using 0.9% saline. Fluids in DKA are best administered via a pump, but absence of a pump should not delay commencement of the initial saline. Avoid using 0.45% (half normal) saline as there is no evidence to suggest that this is of benefit in the management of DKA.

5. Ketone Measurements

Ketone testing is essential for diagnosis of DKA and can indicate effectiveness of management. It is important to note that blood ketone meters and

Urine ketone level		Blood ketone level	Action in DKA: Continue to monitor 4-hrly until ketone-free	Action if not in DKA (Being monitored for risk of developing DKA)
Large	8-16mmol/L (80-160mg/dL)	> 3mmol/L		Risk of DKA, urgent medical review required.
Moderate	1.5-4.0mmol/L (15-40mg/dL)	1.5-3mmol/L		Risk of DKA: report to medical staff. Retest blood glucose & ketones in 2 hours.
Trace	0.5-1.5mmol/L (5-15mg/dL)	0.6-1.5mmol/L		Retest blood glucose & ketones in 2 hours, report to medical staff
Negative	< 0.5mmol/L	< 0.6mmol/L		Continue routine monitoring

urine ketone sticks measure different ketone bodies, and the levels are also different. Blood ketone testing is more effective than urine tests to assess the progress of management. Decreasing levels of blood ketones indicates improvement. Because of the way ketones are metabolised, there may *initially* be a paradoxical rise in *urine* ketones but this does not mean treatment is inadequate if other parameters are improving. Ketones are cleared more slowly from urine, and therefore blood levels are most useful for charting improvement in DKA..

6. Start Insulin

Use any soluble insulin e.g Velosulin, Actrapid, Humulin S, Humalog, Novorapid, Hypurin. Concentration should be 50 units of insulin in 50mls normal saline through a syringe driver. The aim is to give continuous insulin at a sufficient rate to switch off ketogenesis. The following fixed scale will appropriately manage most DKAs:

Blood Glucose	Insulin Rate	10% Dextrose rate
≥14	6 units/hr	nil *
9.0-13.9	3 units/hr	100ml/hr
<9.0	2 units/hr	200ml/hr

If adjustment is required, it is better to increase or decrease the amount or concentration of dextrose infused than to reduce the insulin. In rare cases, increasing the insulin above 6 units may be necessary (See also notes 13 & 14)

7. Other Actions

Guidance on Bicarbonate There is no evidence to support the use of bicarbonate unless there is evidence of cardiogenic shock or other lactic acid-generating conditions.

8. A central line is likely to be of benefit if fluid management is complicated, particularly by severe renal or cardiac failure. In the setting of severe renal or cardiac failure, the fluid regime for DKA should be modified following senior advice.

9. Sepsis may precipitate DKA, but it should be remembered that DKA itself may elevate the neutrophil count and cause respiratory distress. However, if sepsis is strongly suspected, it should be treated aggressively with appropriate antibiotics after cultures have been obtained.

10. Potassium Replacement 40mmols KCl must be given as 2 x 500mls with 20mmols in each, and given via a pump, to avoid administration at greater than 20mmol/hour.

11. Dextrose should be introduced in conjunction with normal saline. It should not be used for rehydration, but is intended to maintain BG at an appropriate level to allow continued administration of insulin.

12. Evidence for using **dextrose** at 10% concentration is mainly anecdotal. However, at this concentration, higher insulin levels can be maintained with enhanced clearance of ketones and therefore correction of acidosis. 20% may also be used, but is more irritant to veins.

13. Hourly Blood Glucose Testing There may be an increased risk of cerebral oedema if blood glucose levels drop too quickly, and so it is advised to avoid a rate of drop of blood glucose of >5mmol/L/hour. It is recognised that bedside fingerprick measurements are less accurate than lab measurements, especially at high readings, and so these should be interpreted with caution. However, it is recognised that it is impractical at present to obtain laboratory measurements hourly.

14. In the early hours of treatment of DKA, it is advised to aim towards blood glucose levels of 9-14mmol/L. **If BG is not falling**, or levels off at >14, the rate of insulin should be increased. (*In insulin resistance, higher rates of insulin may be necessary, but the rate should be increased gradually*) **If BG falls to <9**, the rate of 10% dextrose should be increased above the standard 100ml/hr.

15. Consider Precipitating Factors

Common causes include:

- Insulin omission
- Infection
- Newly diagnosed
- Myocardial infarction