V5.0 – 12/23
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SW566

Queensland Government

Management of diabetic ketoacidosis in adults (age 16 years and over)

Facililty:.....

(Affix identification label here)

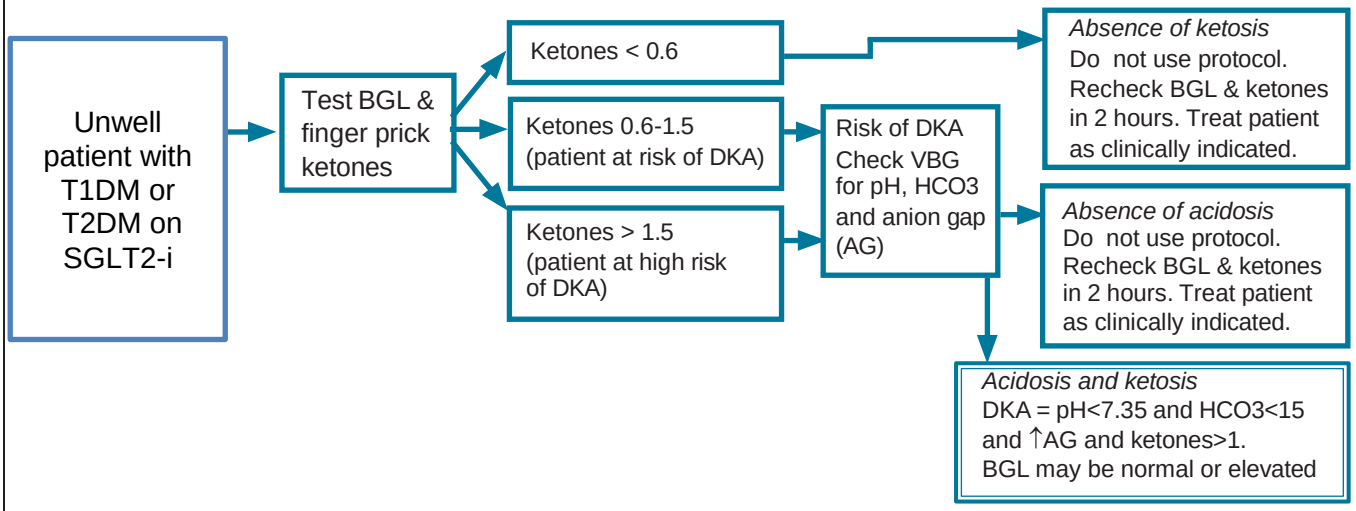
URN:

Family name:

Given name(s):

Address:

Date of birth: Sex: ☐ M ☐ F ☐ I



Protocol use	This protocol is to be used for the management of diabetic ketoacidosis (DKA) and euglycaemic DKA in **adults** over the age of 16 This protocol is ***NOT*** to be used for the treatment of; • Hyperglycaemic hyperosmolar state • The management of DKA in an intensive care unit
Clinical signs and symptoms	• Hyperventilation • Dehydration • Abdominal pain +/- vomiting • Impaired consciousness
ICU consultation	**Refer to ICU for consultation** (if any of the following) • pH < 7.1 • Altered level of consciousness • Severe hypokalemia (< 3mmol/L) • Severe hyponatremia (< 125mmol/L) • Altered blood pressure/severe dehydration • Pregnancy
Key issues	• Initial fluid management • Early potassium (K^+) replacement • Early IV insulin initiation (titrated to blood glucose level [BGL]) • Frequent monitoring

POTASSIUM REPLACEMENT GUIDELINES

All infusions containing potassium must be given via an infusion pump or burette
Maximum concentration = 40mmol/L peripherally to prevent phlebitis.
Exception: isotonic, premixed potassium chloride 10mmol/100mL minibags (commercially premade, ready to use) can be given peripherally. Note: Minibags must be given via an infusion pump.
Maximum rate: **- With burette** = **10mmol/hr**
- With infusion pump = **20mmol/hr**
If maximum rates or concentration are exceeded, cardiac monitoring in a high acuity bed, as well as administration through a large vein with high blood flow (eg. CVC, venous access port, PICC) is required.
For further information on potassium replacement please refer to you local prescribing guidelines.

WARNING

Diabetic ketoacidosis carries a significant mortality rate and close monitoring is essential.
IF THERE IS A SUSPICION OF CEREBRAL OEDEMA OR THE PATIENT IS NOT IMPROVING CALL A CONSULTANT.
Signs of cerebral oedema (see page 4) should be monitored throughout the first 24 hours.

MANAGEMENT OF DIABETIC KETOACIDOSIS IN ADULTS (AGE 16 YEARS AND OVER)

Queensland Government

Management of diabetic ketoacidosis in adults (age 16 years and over)

Facililty:.....

This clinical protocol is a general guide and does not replace clinical judgement

Care should be individualised to meet the specific needs of each patient

Medical officer to tick each step as it is initiated

(Affix identification label here)

URN:

Family name:

Given name(s):

Address:

Date of birth: Sex: ☐ M ☐ F ☐ I

Date: ..... / ..... / ..... Time commenced: ..... : .....hrs Initiating MO:..... Initiating MO to print patient name:.....

Immediate management – 'hour 1'

Step 1 – initial investigation

- ☐ Two IV cannulae
- ☐ FBE, U&E, LFT, BGL, venous blood gas (VBG)
- ☐ Finger prick ketones at triage and end of 'hour 1'
- ☐ Blood cultures

Step 2 – fluid replacement (cannula 1)

- ☐ 0.9% sodium chloride 1000mL/hr. Repeat if hypotensive (systolic BP < 100)

Step 3 – start IV insulin (cannula 2)

- ☐ If K^+ > 3.5mmol/L commence soluble insulin intravenously at 0.1unit/kg/hr (maximum starting dose 10 units/hr)
- ☐ If K^+ < 3.5mmol/L, replace K^+ (cannula 1) , recheck levels and commence insulin infusion once K^+ > 3.5mmol/L

Step 4 – other actions

- ☐ **Prescribe/administer patient's usual long acting insulin**
- ☐ Check βHCG and cardiac enzymes if indicated
- ☐ Undertake septic screen and treat infection appropriately if present
- ☐ Fluid balance chart and neurological observations
- ☐ If patient is using a continuous subcutaneous insulin infusion (CSII) pump - remove it
- ☐ Consider whether cardiac monitoring is required
- ☐ DVT prophylaxis
- ☐ If treating euglycaemic DKA or BGL **<14 mmol/L start 10% glucose at 100 mL/hr**

Step 5 – contact accepting consultant

- ☐ Contact consultant Time: .....

Accepting consultant: Dr .....

.....

Ongoing management – 'hour 2 – 4'

Step 1 – further investigations

- ☐ Hourly BGL
- ☐ U&Es & VBG at end of 'hour 2' and 'hour 4' Finger
- ☐ prick ketones
- ☐ Hourly fluid balance chart (catheter if oliguric)

If indicated/not checked already:

☐ CXR ☐ ECG ☐ CT head and then LP

☐ MSU ☐ Blood cultures ☐ Viral studies

Step 2 – continuation of fluid replacement

Continue 0.9% sodium chloride

- ☐ 500mL/hr for 'hour 2'
- ☐ 500mL/hr for 'hour 3'
- ☐ 250mL/hr for 'hour 4'

Step 3 – potassium replacement (cannula 1)

- ☐ Give K^+ infusion OVER ONE HOUR via "Y" site

If serum K^+ > 5mmol/L or patient anuric - withhold
If serum K^+ 3.5 – 5mmol/L give 10mmol/100mL
If serum K^+ < 3.5mmol/L give 2 x 10mmol/100mL

Step 4 – IV insulin and glucose (cannula 2)

- ☐ Continue initial rate of insulin if BGLs are decreasing (if >14 mmol/L initially) and venous pH at 'hour 2' and 'hour 4' is consistently increasing (finger prick ketones at 'hour 4' should be decreasing)
- ☐ Increase rate of insulin if venous pH is not increasing at 'hour 2' and 'hour 4' or if BGLs rise or do not decrease (if > 14mmol/L)
- ☐ When BGL < 14mmol/L give 10% glucose 100mL/hr via "Y-SITE" (cannula 2) if not already done so and change to variable insulin infusion rate to maintain BGL 9-14mmol/L. Continue 0.9% sodium chloride fluid resuscitation as above

Subsequent management – 'hour 5 +'

Step 1 – further investigations

- ☐ Hourly BGL until IV insulin infusion ceased
- ☐ U&Es & VBG q4hrly until hour 12 then as required
- ☐ Finger prick ketones at end of 'hour 6' then q4h until ketones < 0.6mmol/L

Step 2 – fluid replacement

- ☐ Continue 0.9% sodium chloride infusion at 125mL/hr until patient is fluid replete or eating/drinking

Step 3 – potassium replacement (cannula 1)

- ☐ Continue K^+ replacement to maintain within reference range and continue to monitor K^+ as above with U&Es and VBG

Step 4 – continuation of IV insulin/glucose (cannula 2)

- ☐ Continue insulin at variable rate to maintain BGL 9-14mmol/L. It is likely that the rate will need to be decreased at this point to maintain 9-14mmol/L
- ☐ Allow oral intake if no clinical evidence of ileus, bowel obstruction or acute abdomen. If eating but still requiring IV insulin, consider giving appropriate doses of short-acting subcutaneous insulin

Step 5 – transition to subcutaneous insulin

The patient is ready to transition to the regular insulin regimen when the following criteria are met:

- ☐ patient well and eating/drinking
- ☐ anion gap is normal
- ☐ ketones < 0.6mmol/L
- ☐ long acting insulin has been given at least 2 hours ago (or pump recommenced if relevant)

Ignore mild persistent acidosis if above criteria are met and there is hyperchloraemia. IV insulin and glucose can now be ceased and normal subcutaneous dosing can be continued

Discharge planning

Step 1 – refer for specialist review before discharge

- ☐ Refer to specialist to determine:
  - cause of DKA episode
  - need for diabetes education and review of knowledge and understanding of condition

Step 2 – discharge preparation

Patient not to be discharged until:

- ☐ Ketones <0.6mmol/L and anion gap normal
- ☐ Eating normally and established on routine insulin regimen
- ☐ Given written advice about sick day management

Step 3 – follow up

- ☐ Arrange appropriate follow up/contact with diabetes educator and dietitian within one week of discharge
- ☐ Consider the need for a referral to the mental health team if more than one DKA admission in 12 months
- ☐ Ensure patient has a formal clinic appointment
- ☐ Ensure that a copy of patient discharge letter is sent to patient's GP and diabetes care team

Refer to supplementary notes for further information

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Management of diabetic ketoacidosis in adults (age 16 years and over)

Facililty:.....

This clinical protocol is a general guide and does not replace clinical judgement

Care should be individualised to meet the specific needs of each patient

Flowchart to be completed by medical officer

(Affix identification label here)

URN:

Family name:

Given name(s):

Address:

Date of birth: Sex: ☐ M ☐ F ☐ I

Date: / / Time																						
Hour	**0**	**1**																				
Finger prick																						
BGL																						
Ketones																						
Chemistry																						
Serum glucose																						
Serum sodium																						
Serum potassium																						
Serum chloride																						
Serum bicarbonate																						
Urea																						
Creatinine																						
Effective osmolality ◈																						
Anion gap																						
Blood gases																						
pH: specify venous (V) or arterial (A)																						
pO_2																						
pCO_2																						
SaO_2																						
Fluid/Metabolites (ml/hr)																						
10% glucose																						
0.9% normal saline																						

Legend
◈ Effective osmolality = 2x Na (mmol/L) + glucose (mmol/L)

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SUPPLEMENTARY NOTES

Immediate management

Acute management of diabetic ketoacidosis in adults

This protocol is for the acute management of diabetic ketoacidosis in patients 16 years and over.

If a patient has elevated BGL and ketones but is not acidotic they need to be closely monitored and aggressively managed to prevent progression to DKA.

WARNING: Due to the significant mortality that this condition carries, the following clinical signs would indicate the need for close monitoring. Always discuss these clinical signs and management decisions with senior team members.

- Respiratory rate > 20/min
- Heart rate > 90/min or less than 50/min
- Systolic BP less than 100mmHg
- Circulatory compromise; pale, sweaty, cool or clammy peripheries – mottling indicates severe circulatory compromise (do not use a point of care BGL meter in this case)
- Temperature > 38°C or less than 36°C
- Altered level of consciousness
- Pregnancy
- Anion gap > 16, pH < 7.1, bicarbonate < 10mmol/L

NOTE: The difference between venous and arterial pH is 0.02–0.15 pH units and the difference between arterial and venous bicarbonate is 1.88 mmol/L

Signs of cerebral oedema

Younger patients are at the highest risk of cerebral oedema

How it will present:
- Headaches and/or reduced consciousness level
- Agitation/aggression

How to take action:
- Monitoring for signs of cerebral oedema should start from the time of admission and continue up to at least 24 hours after admission
- If there is suspicion of cerebral oedema or the patient is not improving within 4 hours of admission, call the consultant
- Undertake CT scan to confirm findings
- Consider ICU (an indication for checking arterial blood gases)
- Consider IV mannitol (100mL of 20% over 20 minutes) or dexamethasone 8mg (but only after discussion with the consultant or ICU)

Step 1 - initial investigations

Guidance on ketones:
Capillary finger prick ketones testing is essential for diagnosis of DKA and can indicate effective management. Urine ketones are not used to monitor DKA.
Monitor capillary finger prick ketones regularly until ketone free. Decreasing finger prick ketones can be used as a surrogate for improving acidosis.

Step 2 - fluid replacement

Avoid using 0.45% sodium chloride as there is no evidence to suggest that this is of benefit in the management of DKA. The suggested fluid resuscitation will meet the needs of people within the 50 – 90kg range. Fluids will need to be carefully reviewed and possibly modified if outside this weight range.

Use of large volumes of 0.9% sodium chloride can lead to hyperchloraemic metabolic acidosis, which may cause delayed resolution of acidosis. If the patient is eating, ketones are < 0.6 mmol/L and the anion gap is normal then DKA has resolved and any mild residual acidosis is likely to be a result of hyperchloraemic acidosis.

Step 3 - start intravenous insulin

Document in special instructions section of the IV insulin order form that the patient is on DKA protocol. Use any soluble insulin eg: Actrapid, Humulin R. Concentration should be 50 units of insulin in 49.5mL 0.9% sodium chloride through a syringe driver.

Step 4 - Continuation of intravenous insulin

Long acting (basal) subcutaneous insulin can be introduced in combination with intravenous insulin. There is no need to stop long acting insulin in patients already on it.

Other notes -

Hypoglycaemia:
The blood glucose may fall very rapidly as ketoacidosis improves. Hypoglycemia may result in rebound ketosis driven by counter-regulatory hormones. Once the blood glucose falls to 14 mmol/L, intravenous glucose 10% should be commenced to allow continuation of the insulin infusion to correct the acidosis. The patient will require simultaneous fluid resuscitation with 0.9% sodium chloride.

Guidance on bicarbonate:
There is no evidence to support the use of HCO_3 unless there is evidence of cardiogenic shock or other lactic acid-generating conditions with markedly low pH < 6.9. Must be given with consultant authority

Guidance on phosphate:
There is no evidence to support the use of phosphate replacement unless severe hypophosphatemia (< 0.4mmol/L). Must be given with consultant authority

Ongoing management

Step 3 - potassium replacement

Potassium should not be administered at a rate greater that 20mmol/hr except in the first 4 hours (maximum 40mmol/hr) without consultant authority.

Step 4 - intravenous insulin and glucose

Glucose should be introduced in conjunction with 0.9% sodium chloride. Evidence for using 10% glucose is lacking and mainly anecdotal. However, at this concentration, higher insulin levels can be maintained with enhanced clearance of ketones and resolution of acidosis. It is not meant for re-hydration but glucose control.
While there is no specific evidence suggesting avoiding a rate of drop of BGL of 5mmol/hr, there may be an increased risk of cerebral oedema if BGLs drop too quickly. The aim is to maintain the glucose between 9-14 mmol/L until ketones are negative or the infusion is stopped. If the BGL is < 9 mmol/L, the infusion rate of glucose should therefore be increased.
Avoid hypoglycaemia as this can cause rebound ketosis.

Subsequent management

Step 5 - transition to subcutaneous insulin

Long acting/basal subcutaneous insulin needs to be commenced at least 2 hours prior to ceasing the intravenous insulin. If the patient's usual long acting subcutaneous insulin was continued through the admission as advised in immediate management, the intravenous insulin can be stopped as soon as the other criteria are met, which may reduce the length of stay.

If the patient was diagnosed with diabetes this admission, an insulin regimen will need to be developed.

Consider precipitating factors

Common causes include:
- Omission of insulin
- Infection
- Newly diagnosed diabetes mellitus
- Myocardial infarction
- Combination of the above

Discharge planning

Step 1 - Refer for specialist review before discharge

Diabetes specialist review team should include:
- Diabetes educator
- Dietitian
- Physician specialising in diabetes
- Psychologist

Problems contributing to DKA episode:
- Errors in insulin administration
- Faulty equipment
- Practical problems
- Psycho-social issues requiring psychological support (especially recurrent DKA)

Diabetes education:
Some or all of the following aspects should be considered and discussed between the diabetes educator/dietitian and patient:
- Patient knowledge and understanding of the condition
- Sick day management – provide written plan (examples provided at: http://clinicalexcellence.qld.gov.au/resources/diabetes-resources/sick-day-management)
- Equipment – pens, syringes and pumps
- Home blood glucose monitoring
- Diet

References:

Joint British Diabetes Societies for Inpatient Care (JBDS-IP) Guidelines
https://abcd.care/sites/abcd.care/files/site_uploads/JBDS_Guidelines_Current/JBDS_02_DKA_Guideline_with_QR_code_March_2023.pdf

NSW – Agency for Clinical Innovation
Management of DKA and HHS in the emergency dept.
https://aci.health.nsw.gov.au/networks/eci/clinical/clinical-tools/endocrine/diabetic-ketoacidosis-dka-hyperosmolar-hyperglycaemic-state-hhs

The Queensland Diabetes Clinical Network would like to acknowledge Dr Kunwarjit Sangla and the Townsville HHS for their assistance in developing this protocol.

If you have any questions or feedback about this document please contact the Queensland Diabetes Clinical Network Coordinator on QLDDiabetesNetwork@health.qld.gov.au