

CONTROLLED DOCUMENT

Guidelines for the management of Diabetic Ketoacidosis (DKA)

CATEGORY:	Clinical Guidelines
CLASSIFICATION:	Clinical
Controlled Document Number:	CG031
Version Number:	4.0
Controlled Document Sponsor:	Clinical Guidelines Group
Controlled Document Lead (Author):	Punith Kempegowda Sandip Ghosh Parth Narendran
Approved By:	Clinical Guidelines Group
On:	December 2016
Review Date:	December 2019

Management of

DKA



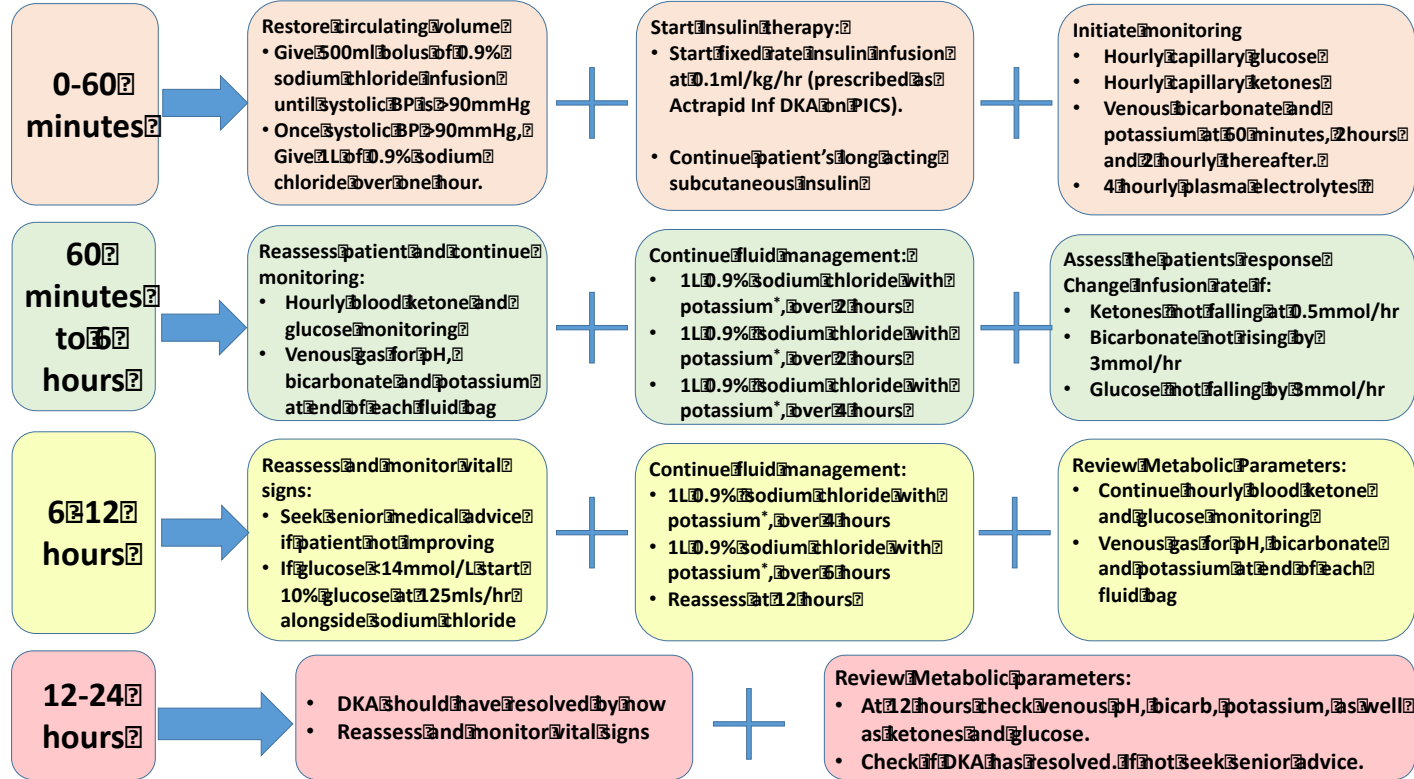
- A** Airway
- B** Breathing
- C** Circulation
- D** Diabetes
- E** Electrolytes and pH
- F** Fluid replacement
- G** Hourly Glucose
- H** HbA1C
- I** Fixed rate Insulin
- J** Clinical Judgement
- K** Hourly Ketones
- and**
- D** Diabetes team referral

Diagnostic Criteria

- All three of the following should be present:
1. Capillary blood glucose ≥ 11 mmol/L or history of diabetes[†] (glucose may be ≤ 11 mmol/L in Euglycaemic ketoacidosis)
 2. Capillary ketone ≥ 3 mmol/L or Urine ketones $\geq 2+$.
 3. Venous pH ≤ 7.3 and/or bicarbonate ≤ 15 mmol/L.

When to refer to Critical Care Unit

- Young (18-25) or elderly
- Pregnancy
- Heart or liver or kidney failure
- Severe DKA judged by: blood ketones ≥ 6 mmol/l, bicarb ≤ 5 mmol/l, pH ≤ 7.1 , hypokalaemia, GCS ≤ 12 , SpO₂ $\leq 92\%$, brady/tachycardia or anion gap ≥ 16



***Potassium Supplementation**
 This should be according to blood K⁺ (mmol/L):

- >5.5 : No potassium replacement
- $3.5-5.5$: 40mmol per litre of infusion fluid
- <3.5 : Senior review to assess the risks and benefits of replacement

Resolution of DKA

- Resolution is defined as ketones less than 0.6mmol/L and venous pH over 7.3
- If DKA has resolved-
 - convert to \leq / insulin if patient eating and drinking well
 - Switch to variable rate intravenous insulin infusion if patient is unwell or unable to eat and drink

[†] Rule out Euglycaemic ketoacidosis and Hyperglycaemic Hyperosmolar State (HHS) in high risk acutely unwell patients with diabetes (Eg: Pregnancy, those on GLT-2 inhibitors (gliflozins))

A. Diagnostic criteria

The diagnosis of DKA requires all three of the following criteria to be met:

1. Blood glucose > **11mmol/L** or known diabetes mellitus*
2. Ketonaemia \geq **3.0 mmol/L** or significant **ketonuria** (more than 2+ on standard urine stick).
3. Bicarbonate < **15mmol/L** and/or **venous pH < 7.3**. (Use venous readings to assess acidosis rather than arterial unless gas exchange must be assessed)

Euglycaemic ketoacidosis (Blood glucose \leq 11mmol/L) can develop in certain high risk population such as pregnant patients or patients on SGLT-2 inhibitors (gliflozins). Therefore, we recommend testing for ketoacidosis in acutely unwell patients with diabetes. Also, **Hyperglycaemic Hyperosmolar State** (HHS) should be considered in acutely unwell patients with diabetes and in the absence of ketoacidosis.

B. Immediate management: 0-60 minutes

- Action 1: Intravenous access and initial investigations.
 - Preform a rapid **ABC** (airway, breathing and circulation) assessment of your patient
 - Obtain **intravenous (IV) access** with a large bore IV cannula and commence fluid replacement (action 2).
 - Full **clinical assessment** and examination.
 - Record and act on the initial basic **observations** (respiratory rate, pulse etc)
 - Record the patients **Glasgow coma score** and note that a drowsy patient in the context of DKA is serious, therefore seek early critical care input
 - Request **initial investigations** (that may aid in identifying an underlying cause), which should include blood ketones, capillary blood glucose, venous plasma glucose, urea and electrolytes, venous blood gas, full blood count, blood cultures, ECG, chest radiography (if indicated), urinalysis, continuous cardiac monitoring, pulse oximetry and a pregnancy test (women of child bearing age).
 - Consider the **precipitating cause** and treat appropriately
- Action 2: Restoration of the circulating volume.
 - Hypotension is likely due to a low circulating volume, but consider other causes such as sepsis or heart failure.
 - **0.9% sodium chloride** is the crystalloid of choice in fluid resuscitation (with premixed potassium chloride if necessary) as it is compliant with NPSA recommendations.
 - If **systolic blood pressure (SBP) is < 90mmHg**, give 500ml of 0.9% sodium chloride over 10-15 minutes. If SBP remains < 90mmHg, give a further 500ml of 0.9% sodium chloride whilst awaiting senior input. If there is no improvement despite fluid resuscitation, consider alternative causes for hypotension and seek critical care input.
 - **Once SBP is >90mmHg**, give 1L of normal 0.9% sodium chloride over 1 hour.
- Action 3: Commence a fixed rate intravenous insulin infusion
 - Continue the patient's **long acting insulins** subcutaneously
 - Fixed rate insulin infusion should be based on **weight** (estimate if not available).
 - Commence infusion at a rate of **0.1 units/kg/hr** (prescribed as Actrapid inf DKA on PICS)
 - Do not give a primary bolus of insulin, just start the infusion as soon as possible.
- Action 4: make a referral to the diabetes team for early input.

C. 60 minutes to 6 hours

- Action 1: Re-assess patient, monitor vital signs
 - **Review patient hourly** to assess progress in glucose and/or ketone reduction.
 - If oxygen saturation falls, perform an arterial blood gas measurement and request a chest x-ray.
 - Record fluid balance. Aim for a minimum urine output of no less than 0.5ml/kg/hr.
- Action 2: Restoration of circulating volume.
 - If systolic blood pressure (SBP) is less than 90mmHg, refer to action 2 in section B.
 - If SBP is >90mmHg, follow the fluid replacement as shown in table 1.

Table 1: Typical fluid replacement regimen for a previously well 70kg adult.

Fluid	Volume
0.9% sodium chloride 1L*	1000ml over 1 st hour**
0.9% sodium chloride 1L with potassium chloride	1000ml over the next 2 hours
0.9% sodium chloride 1L with potassium chloride	1000ml over the next 2 hours
0.9% sodium chloride 1L with potassium chloride	1000ml over the next 4 hours
0.9% sodium chloride 1L with potassium chloride	1000ml over the next 4 hours
0.9% sodium chloride 1L with potassium chloride	1000ml over the next 6 hours

*Potassium chloride maybe required if more than 1 litre of sodium chloride has been given already to resuscitate hypotensive patients.

**This should have been given in the A&E department as part of the initial management.

- Action 3: Potassium replacement
 - Use table 2 to guide the potassium content of your fluid replacement.

Table 2: Potassium replacement

Potassium level in first 24 hours (mmol/L)	Potassium replacement in mmol/L of infusion solution
>5.5	nil
3.5-5.5	40
Below 3.5	Senior review as additional potassium needs to be given.

- Action 4: Review metabolic parameters
 - Glucose should come down at a rate of about 50% in the first 4 hours of treatment.
 - Measure blood ketones and capillary glucose hourly.
 - Assess resolution of ketoacidosis by assessing progress in blood ketones reduction.
 - If blood ketones are not falling by at least 0.5mmol/L/hr, increase FRIII rate by 1.0 unit/hr increments hourly.
 - If ketones and glucose are not showing the expected improvement, check that the insulin infusion pump is working and connected.
 - Repeat a venous blood gas at 60 minutes, 2 hours and 2 hourly thereafter.
 - Monitor serum potassium and replace as appropriate, referring to table 2.
- Action 5: Avoid Hypoglycaemia: If glucose falls to <14.0mmol/L, commence **10% glucose** at 125ml/hr alongside the 0.9% sodium chloride solution.
- Action 6: Identify and treat precipitating factors and handover plan to the doctor on the next shift as appropriate

D. 6 to 24 hours

During this period, continue IV fluid replacement and insulin administration, assess for complications of treatment, and avoid hypoglycaemia. Please ensure the plan is handed over to the doctor on the next shift as appropriate

- Action 1: Re-assess patient, monitor vital signs: Ensure a referral is made to the specialist diabetes team
- Action 2: Review biochemical and metabolic parameters: At 6 hours, check venous pH, bicarbonate, potassium, along with blood ketones and glucose.
- Action 3: Assess for resolution of DKA (refer to section E). If DKA has resolved, go to section F. If DKA has not resolved, refer to action 4 in section C.

E. Resolution of DKA

DKA resolution is defined as ketones <0.6 mmol/L and venous pH >7.3.

F. Stopping FRIII and Conversion to subcutaneous insulin

Convert to a subcutaneous insulin regime when DKA has resolved and the patient is eating and drinking. This is ideally managed by the specialist diabetes team. Patients with newly diagnosed type 1 diabetes could be started on Levemir at 0.25 units/Kg total dose subcutaneously delivered through a twice a day regime to prevent rebound ketosis. If the DKA has resolved but the patient is not eating or drinking, switch fixed rate insulin infusion to variable rate insulin infusion and continue IV fluids as appropriate.

G. Serious complications of DKA and treatment

Hypo and hyperkalaemia- An elevated serum potassium is likely to be due to the extracellular shift of potassium in acidotic conditions. Treatment using insulin will drop the serum potassium.

Hypoglycaemia-With the insulin treatment the blood glucose may fall very rapidly. This may result in a rebound ketoacidosis due to counter-regulatory hormones. Severe hypoglycaemia can lead to brain injury and death.

Cerebral Oedema-The exact cause of cerebral oedema during DKA treatment is unknown however initial hypotheses believe it has an iatrogenic cause. It is more common in children than adults.

Pulmonary oedema-This has been rarely reported in DKA and occurrence within the first few hours may likely be iatrogenic due to rapid infusion of crystalloids. Elderly or cardiac impaired patients are at most risk. (Clinical judgement/ senior review required)

H. Severe DKA and Special patient groups

- Severe DKA is judged by the presence of one of the following: blood ketones >6 mmol/l, bicarb <5mmol/l, pH <7.1, hypokalaemia (<3.5 mmol/l), GCS <12, SpO2 <92%, brady/tachycardia or anion gap >16. These patients need early senior review to consider management at intensive care.
- Young (18-25) or elderly, Pregnant women, patients with heart or liver or kidney failure or other serious co-morbidities need specialist input to consider management at intensive setting as soon as possible and special attention needs to be paid to their fluid balance.

Please note: Co-existing comorbidities and aetiology leading to DKA should be considered and clinical judgement should be ascertained while following the guidelines. Please contact the diabetes team or the medical registrar on-call if any queries or concerns.

I. References

1. Joint British Societies Inpatient Care Group (2013), *The management of diabetic ketoacidosis in Adults, Second Edition*. Accessed on web: http://www.diabetologists-abcd.org.uk/jbds/JBDS_IP_DKA_Adults_Revised.pdf