# Diabetic Ketoacidosis (DKA)

## *Executive summary*

## Introduction

Diabetic ketoacidosis is an acute, major, life-threatening complication of diabetes that mainly occurs in patients with type 1 diabetes, but it is not uncommon in some patients with type 2 diabetes. This condition is a complex disordered metabolic state characterized by hyperglycaemia, acidosis and ketonuria.

This might be the **FIRST** presentation of diabetes mellitus.

## Target users

* Doctors
* Nurses

## Target area of use

* Ward

## Key areas of focus / New additions / Changes

This guideline addresses the management of DKA in our setting. It does not address ongoing management of diabetes after the initial admission.

## Limitations

Unavailability of blood gas analyzers means we are unable to get blood pH values and therefore have to wait at least 2 hours to get bicarbonate results in order to confirm the diagnosis.

## Presenting symptoms and signs

Polydipsia, polyphagia, malaise, generalized weakness, nausea, vomiting, weight loss, decreased perspiration, altered consciousness, recurrent boils, persisting vaginal yeast infection, blurred vision, excessive tiredness

**WITH**

Fasting blood glucose of 7.0 mmol/L or higher

**OR**

A two hour post prandial glucose level of 11.1 mmol/l or higher

**OR**

A random blood glucose of 11.1 mmol/l or higher plus the classic symptoms of diabetes mellitus.

**AND**

Presence of ketones of ++ and above in urine

**AND**

Acidosis with serum bicarbonate of less than 15mmol/l or blood pH less than 7.3.

## Classification

**Mild DKA** In children and young people with pH 7.2-7.29 and/or bicarbonate <15

**Moderate DKA** Children and young people with pH less than 7.1-7.19 and or bicarbonate <10

**Severe DKA** Children and young people with a pH less than 7.1 and/or bicarbonate <5.

## Examination findings

* Looks sick
* Dry skin
* Laboured respiration
* Dry mucous membrane
* Decreased skin turgor
* Decreased reflexes
* Characteristic acetone breath
* Tachycardia
* Hypotension
* Tachypnea
* Hypotension
* Tachypnoea
* Hypothermia
* Fever, if infection is present
* Confusion
* Coma
* Abdominal tenderness/nausea/ vomiting

## Differential diagnosis

Many of these may also precipitate DKA; beware of co-existing disease processes

* Hypoglycaemia
* Subdural hematoma
* Stroke
* Cerebral malaria
* Meningitis
* Sepsis

## Management

* **Call for help** (other doctors, senior nurses).
* **Check Airway, Breathing and Circulation.** Ensure the patient is alive!
  + **Airway:** Ensure airway is patent, if comatose insert an airway, if recurrent vomiting insert NG tube, aspirate and leave on open drainage
  + **Breathing:** Give 100% oxygen
  + **Circulation:** Insert IV Cannula and take samples, measure blood pressure and heart rate, cardiac monitor for T-waves (peaked in hyperkalaemia)
* **Get two intravenous access** with the widest cannula possible for the patient (try sizes 20 pink cannula, 22 blue cannula for children and 18 green cannula, 16 grey cannula for adults).
* **Initial fluid bolus**
  + If in shock, give 20 mls/kg bolus of 0.9% normal saline after determining true weight. Give this over 15 minutes. Following initial 20 ml/kg bolus, shocked patient should be reassessed and further boluses of 10ml/kg may be given if required, to restore adequate circulation up to a total of 40ml/kg at which stage inotropes should be considered
  + If not in shock, All children and young people with mild moderate or severe DKA who are not shocked and are felt to require IV fluids should receive a 10ml/kg 0.9% sodium chloride bolus over 60 minutes
* **Initial investigations**
  + Take samples: Blood: Blood glucose, urea and electrolytes; K, Na, HCO3, FBC, blood culture, Urine dipstick, urine: culture & sensitivity.
  + Chest X-ray

### Immediate treatment in children

Treat DKA with oral fluids and subcutaneous insulin **only** if the child or young person is alert, not nauseated or vomiting, and not clinically dehydrated. If DKA is treated with oral fluids and subcutaneous insulin, ensure that the child or young person is recovering by monitoring for resolution of ketonaemia and acidosis.

Treat DKA with intravenous fluids and intravenous insulin if the child or young person **is not alert, is nauseated or vomiting or is clinically dehydrated.**

**Fluid replacement:** Use 0.9% normal saline.

Requirement = Deficit + Maintenance

In children and young people with DKA, calculate their total fluid requirement for the first 48 hours by adding the estimated fluid deficit to the fluid maintenance requirement. The fluid deficit should be replaced over 48 hours alongside maintenance fluids.

When calculating the fluid requirement for children and young people with DKA: Assume

**5% dehydration** **in mild DKA** (indicated by blood pH 7.2-7.29 and / or bicarbonate < 15 mmol/l).

**7% dehydration** **in moderate DKA** (indicated by a blood pH of 7.1-7.19 and /or bicarbonate < 10 mmol/L)

**10% dehydration** **in severe DKA** (indicated by a blood pH <7.1 and /or bicarbonate < 5 mmol/L)

**In children with shock:** the volume of any fluid boluses given for resuscitation in children with shock should **not** be subtracted from the estimated fluid deficit

**In all non-shocked patients:** the initial 10 ml/kg bolus given to all non -shocked patients requiring IV fluid should be subtracted from total calculated fluid deficit.

*Maintenance fluid*

Maintenance fluid volumes should be calculated using the Holiday-Segar formula the traditional method of calculating fluid volume in the UK. Calculate the maintenance fluid requirement for children and young people with DKA using the following 'reduced volume' rules:

100 ml/kg/day for the first 10 kg of body weight

50 ml/kg/day for the next 10 to 20 kg

20 ml/kg for each additional kilogram above 20 kg

**Large fluid volumes are associated with an increased risk of cerebral oedema.** Aim to replace the fluid deficit evenly over the first 48 hours in children and young people with DKA.

*Fluid calculation*

Calculate the fluid deficit (either 5%,7% or 10% dehydration depending on whether the patient has mild moderate or severe DKA, subtract the initial 10mls/kg bolus then divide this over 48hours and add to the hourly rate of maintenance fluid volume, giving the total volume evenly over the next 48 hours

*Type of fluid*

Use 0.9% sodium chloride with 20 mmol potassium chloride in 500 ml (40 mmol/L) until blood glucose levels are less than 14 mmol/L

Do not give oral fluids to a child or young person who is receiving intravenous fluids for DKA until ketosis is resolving and there is no nausea or vomiting, if oral fluids are given before the 48 hour rehydration is completed, the IV infusion needs to be reduced to take account of oral intake

Think about stopping intravenous fluid therapy for DKA in a child or young person if ketosis is resolving, they are alert, and they can take oral fluids without nausea or vomiting.

Note: Do not give children and young people with DKA additional intravenous fluid to replace urinary losses.

**Potassium:**

Levels of potassium in the blood will fall once insulin is commenced

Add K to fluid when patient is resuscitated and has started passing urine.

Ensure that all fluids (except any boluses given) contain 40 mmol/L potassium chloride, unless there is evidence of renal failure. Hypokalaemia can occur up to 48 hours after starting DKA treatment

Where potassium is above the upper limit of normal range at presentation, potassium is only added to IV fluids after patient has passed urine (to confirm they are not anuric) or after the potassium has fallen to within the upper limit of normal, which it will after the initial 10ml/kg bolus has been given

If child with DKA develop hypokalemia (potassium below 3mmol/Litre, you may further reduce insulin infusion

**Insulin:**

Once rehydration fluids and potassium are running, blood glucose levels will start to fall

**Start an intravenous insulin infusion 1–2 hours** after beginning intravenous fluid therapy in children and young people with DKA. There is evidence that cerebral edema is more likely if insulin is started early

Add 50 U actrapid to 50 ml 0.9% saline.

Use soluble insulin infusion at a dosage between 0.05 and 0.1 U/kg/hour.

**Do not give bolus doses of intravenous insulin.**

Do not change from intravenous insulin to subcutaneous insulin in a child or young person with DKA until ketosis is resolving, they are alert, and they can take oral fluids without nausea or vomiting.

Start subcutaneous insulin in a child or young person with DKA at least 30 minutes before stopping intravenous insulin.

**Continuing management:**

Continue with 0.9% sodium chloride containing 20 mmol potassium chloride in 500ml until blood glucose levels have fallen to 14mmol/L

Once blood glucose has fallen to 14 mmol/l add glucose to the fluid, change the fluid to contain 5% glucose, use 500 ml bags of 0.9% sodium chloride with 5% glucose and 20 mmol potassium chloride in 500 ml

Stop intravenous fluid therapy when ketosis is resolving and oral fluids are tolerated

Switch from intravenous to subcutaneous insulin once ketosis is resolving and child is tolerating fluids without nausea and vomiting. If ketosis is persisting, continue to give insulin at 0.05 unit/kg/hour.

Start subcutaneous insulin at least 30 minutes before stopping intravenous insulin according to local protocol.

### Immediate treatment in adults

**Fluid replacement:** Use 0.9% normal saline.

* Typical fluid deficit is 100 ml/kg. Replace over 48 hours. Initially give 1 litre in 1st hour, 1L over 2 hours, 1 l over 2 hours, Il over 4 hours, 1L over 4 hours.
* Most patient will require 4-6 litres of fluid in the first 24 hours.
* Review fluid balance 4-6 hourly.

**Insulin:** Start an infusion after rehydrating with 1-2 litres of 0.9% normal saline.

Add 50 U actrapid to 50 ml 0.9% saline. Infuse insulin continuously at 0.1 U/kg/hour. Aim for decreasing blood glucose by 3 mmol/L per hour and increasing bicarbonate by 3 mmol/l/hour. Run insulin in one iv line, while you run normal saline in the other line.

Continue fixed rate insulin until bicarbonate is > 18 mmol/l. After then, switch to sliding scale insulin for 24 hours to enable estimation of 24 hour insulin requirement. Use table 2 below to guide this.

## Table:

|  |  |
| --- | --- |
| **Blood glucose (mmol/l per hour)** | **Insulin Infusion (units/hour)** |
| 0.0-2.0 | Stop insulin-call doctor on duty |
| 2.1-4.0 | Call doctor on duty |
| 4.1-7.0 | 0.5-1 |
| 7.1-11.0 | 2 |
| 11.1-20.0 | 4 |
| > 20.0 | 7 & call doctor on duty |

When glucose is < 14 mmol/l, add 5% glucose to run with 0.9% saline and prevent hypoglycaemia. Aim to maintain blood sugar at 8-12 mmol/l.

**Potassium replacement:** Add K to fluid when patient is resuscitated and has started passing urine. Typical deficit is 3-5 mmol/kg. Plasma K falls with insulin administration. Use table 1 above.

### Transition from iv insulin and fluids

iv fluids can be stopped 1–2 hours after substantial consumption of oral fluids without vomiting, if there are no ketones and the serum HCO3 is above 15 mmol/l.

Subcutaneous insulin injection can be started when iv fluids are no longer needed. Pre- supper or pre-breakfast time is most convenient for starting or restarting intermediate- or long-acting insulin. Before then, rapid-acting or regular insulin 0.25 U/kg subcutaneously can be given every ∼6 hours, and the insulin infusion stopped 60–120 minutes after the first subcutaneous dose of regular insulin or 60 minutes after a rapid-acting insulin analog.

Patients should not be kept in the hospital simply to adjust insulin dosage because food, activity, and psychosocial environment are not normal in the hospital setting. Therefore, insulin requirements will not be particularly informative for home management.

Established patients with DKA can resume their usual home dose of insulin.

### Ongoing inpatient management

* Check serum K, HCO3 & glucose every 6 hours.
* Do hourly temperature, BP, neurological observations (GCS or BCS) , fluid balance and bedside blood sugar.
* If the patient has not passed urine by one hour into resuscitation, consider passing urinary catheter. Aim for a urinary output of > 0.5 ml/kg/hour.
* Change fluids to 0.9% normal saline with 5% glucose once the plasma glucose concentration falls below 14 mmol/l in children and young people with DKA.
* Consider NG tube if vomiting or drowsy.
* **Do not give intravenous sodium bicarbonate to patients with DKA.**

Find and treat the cause of the DKA e.g. infection or other intercurrent illness, poor adherence to meds for previously known patients. Investigate as appropriate e.g. Chest X-ray, FBC, Blood culture, urine culture.

Stop iv insulin infusion when BM is between 11.1-13.9 mmol/l and serum HCO3 > 15 mmol/l. **Then switch to sc insulin at 0.5-0.8 U/kg in divided doses**. Note that we usually have soluble insulin (actrapid) and isophane insulin (insulatard) available. Mixtard 30:70 is available for staff and their dependent relatives only.

### Long term care of diabetes

At least in the short term, all children and many adults will need to remain on insulin. They should be referred to EFSTH or Pakala clinic in Banjul on discharge from the ward, as these clinics are able to provide insulin therapy to outpatients.

Adults whose ketoacidosis has very rapidly resolved within 24 hours of admission may be switched to oral therapy prior to discharge from the ward. Guidance for their long term care can be found in the diabetes mellitus guideline.

## Key Issues for Nursing care

**Assess skin turgor, mucous membranes, and thirst**: This is to provide baseline data for further comparison. Skin turgor will decrease and tenting may occur. The oral mucous membranes will become dry, and the client may experience extreme thirst.

**Monitor hourly intake and urine output:** Oliguria or anuria results from reduced glomerular [filtration](https://nurseslabs.com/fluid-and-electrolytes/) and renal blood flow. Strict fluid balance including oral fluids, using fluid balance charts, urinary catheterization may be required in sick children.

**Monitor hourly capillary blood glucose measurements**

**Monitor respirations, e.g., acetone breath, Kussmaul’s respirations**: Acetone breath is due to the breakdown of acetoacetic acid. Kussmaul’s respiration (rapid and shallow breathing) represent a compensatory mechanism by the respiratory buffering system to raise arterial pH by exhaling more carbon dioxide.

**Monitor level of consciousness,** using modified Glasgow coma score, because of increased risk of cerebral edema.

**Monitor heart rate**: Compensatory mechanism results in peripheral vasoconstriction with a weak, thready pulse that is easily obliterated.

**Monitor BP especially for orthostatic** [**hypotension**](https://nurseslabs.com/hypovolemic-shock-nursing-care-plans/): Decreased blood volume may be manifested by a drop in systolic [blood pressure](https://nurseslabs.com/cardiovascular-system-anatomy-physiology/) and orthostatic hypotension. **Assess for signs of infection and inflammation**: Infection is a common cause of DKA. Signs of infection includes fever, chills, [dysuria](https://nurseslabs.com/impaired-urinary-elimination/), and increased WBC count. **Observe client’s feet for ulcers, infected toenails,and provide wound care where necessary:** Due to impaired circulation in diabetes, foot injuries are predisposed to poor wound healing.

**Observe aseptic technique during IV** [**insertion**](https://nurseslabs.com/muscular-system-anatomy-physiology/) **and medication administration**: Elevated blood sugar weakens the immune system thus clients are more [prone](https://nurseslabs.com/patient-positioning/) to infection.

**Administer** [**antibiotics**](https://nurseslabs.com/antibiotics/) as indicated: Early initiation of [antibiotic](https://nurseslabs.com/antibiotics/) may help to prevent [sepsis](https://nurseslabs.com/sepsis-nursing-care-plans/).

**Teach signs of hypoglycaemia:** eg, dizziness, sweating, hunger, pallor, diaphoresis, nervousness, and tremors. These are signs of excessive insulin dosage, resulting in hypoglycemia. Early recognition of these symptoms promotes immediate intervention.

**Determine client’s dietary program and usual pattern**: Recognizes deficits and deviations from therapeutic needs

**Monitor weight daily,** can be helpful in assessing fluid balance

## References

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Internal Diabetes Foundation clinical guidelines for the management of diabetes. American Diabetes Foundation-Diabetes care Guidelines

Diabetic Ketoacidosis and Hyperglycemic Hyperosmolar Nonketotic Syndrome Nursing Care Plans <https://nurseslabs.com/diabetic-ketoacidosis-nursing-care-plans/>(Accessed on 16/8/2018)

BSPED Interim Guideline for the Management of Children and Young People under the age of 18 years with Diabetic Ketoacidosis. Updated January 2020

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| 1.0 | New document |  |
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