



# Diabetic Ketoacidosis

## Overview

Make the diagnosis  
Establish venous access  
Fluids  
Insulin  
Monitoring  
Underlying cause

**NB** There is no difference in the management of DKA in a new or established patient

## Definition

Blood glucose  $> 11$  mmol/L  
pH  $< 7.3$   
Bicarbonate  $< 15$  mmol/L  
AND  
more than 5% dehydrated  
and/or vomiting  
and/or drowsy  
and/or clinically acidotic

## Features of DKA

Polyuria, polydipsia, incontinence  
Thirst, polydipsia  
Abdominal pain  
Vomiting  
Kussmaul breathing  
Acetone on breath  
Dehydration, hypotension, collapse  
Disturbed consciousness  
Coma

## Features of shock

Poor capillary return  
Impaired consciousness  
BP may be normal or low  
Thready, rapid pulse

*NB Urine output may remain fair because of osmotic diuresis*

## Features of Cerebral Oedema

Headache  
Irritability  
Slowing of pulse  
Rising blood pressure  
Reducing conscious level

*NB These features usually present a few hours after commencing treatment but can occur very early*

# Biochemical Assessment and Monitoring

## Blood

*All new diabetes patients*

Glucose

U&Es including Bicarbonate

Thyroid function tests

FBC

HbA1c

10ml plain tube for possible autoantibodies  
(HISS Order Set /NEWDIA)

*for DKA*

Gases (venous usually sufficient)

Blood culture

Osmolality

## Urine

*All patients*

Glucose, Ketones (test all urine and record results)

*for DKA*

Hourly volume, culture



## Other monitoring etc in DKA

Measure **current weight** if at all possible

BP

ECG monitor

Nil by mouth

NG Tube if unconscious or evidence of gastric distention

Neuro-obs

Repeat biochemistry frequently (~2hrly) until patient stable

# Fluids for DKA - use with DKA IV Fluid Calculation Sheet



1. Treat shock with 10ml/kg N Saline. May repeat once before discussing with a consultant.
2. Calculate fluid deficit - see A, B, C and D on calculation sheet
3. Determine maintenance fluid volume per kg from age:

0-2 years	160ml per kg
3-5 years	140ml per kg
6-9 years	120ml per kg
10-14 years	100ml per kg
>14 years	60ml per kg

**NB Maintenance calculation is for 48 hours**

*Weigh the child and compare with previous known weights and centile charts - access the electronic medical record for existing patients*

4. Calculate hourly fluid rate (for 48h)

$$\text{Hourly Rate (ml)} = \frac{[48\text{h MAINTENANCE (C x E)} + \text{DEFICIT (D x 1000)}] - \text{Volume used to treat shock}}{48}$$

5. Double check all calculations and have someone else do so independently - if you are in any doubt **ASK**

# DKA Treatment - Which Fluids?



## General Points:

Treat shock (resuscitate) with Normal Saline

Sodium Bicarbonate is very rarely indicated and may be harmful - only consider in Intensive Care Unit after discussion with consultant - dose would be 0.5mmol/kg over 30 minutes

Potassium can usually be added to bags immediately after resuscitation (assuming urine output) - 20 mmol/500ml. Monitor T waves and adjust KCl according to electrolyte results. Insulin makes K fall.

Phosphate - it is normal for patients in DKA to have a low phosphate level as this is a plasma buffer. There is no evidence to support adding additional phosphate.

Initially use 0.9% saline.

Generally, once the blood glucose has fallen to 14 mmol/l add glucose to the fluid.

If this occurs **within** the first 6 hours, the child may still be sodium depleted. Discuss this with consultant, who may wish to continue with Normal saline and added dextrose.

If this occurs **after** the first 6 hours and the child's plasma sodium level is stable, change the fluid type to 0.45% saline/5% dextrose.

After 1st 12h, and assuming that the patient is improving, if they have already changed to 0.5N Saline + 5% Dextrose, there is no need to change back to Normal Saline if glucose > 14mmol/L - **ADJUST the INSULIN**



# DKA Treatment - Insulin

Insulin is essential to switch off ketogenesis

Make up a solution of 1 unit per ml. of human soluble insulin (e.g. Actrapid) by adding 50 units (0.5 ml) insulin to 49.5 ml 0.9% saline in a syringe pump. Attach this using a Y-connector to the IV fluids already running.

Do not add insulin directly to the fluid bags.

Run at 0.1 units/kg/hour (0.1ml/kg/hour).

If the rate of blood glucose fall exceeds 5 mmol/l per hour, or falls to around 14 mmol/l, add dextrose (5-10% equivalent) to the IV fluids running (see “fluids” above). The insulin dose needs to be maintained at 0.1 units/kg/hour to switch off ketogenesis.

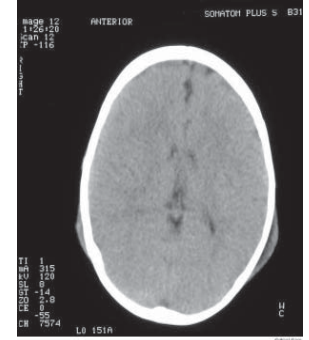
Do not stop the insulin infusion while dextrose is being infused, as insulin is required to switch off ketone production. If the blood glucose falls below 4 mmol/l, give a bolus of 2 ml/kg of 10% dextrose and increase the dextrose concentration of the infusion.

10% dextrose with 0.45% saline can be made up by adding 7.5ml NaCl 30% to 500ml 10% Dextrose. (remember to consider if KCl required)

Once the pH is above 7.3, the blood glucose is down to 14-17 mmol/l, and a dextrose-containing fluid has been started, consider reducing the insulin infusion rate, but to no less than 0.05 units/kg/hour.

Blood glucose rises out of control, or the pH level is not improving after 4-6 hours consult senior medical staff, re-evaluate (possible sepsis, insulin errors or other condition), and consider starting the whole protocol again.

# DKA Treatment - Cerebral Oedema



## Symptoms and Signs:

Headache, slowing of heart rate, rise in BP  
Change in neurological status - restlessness, irritability, drowsiness, incontinence.  
Specific neurological signs e.g. cranial nerve palsies  
Abnormal posturing

Highest risk 12-18h after beginning rehydration

Inform senior staff immediately

Treat in ICU

Document carefully

## Management:

Exclude hypoglycaemia as a possible cause of any behaviour change

Give Mannitol 1 g/kg stat (= 5 ml/kg Mannitol 20% over 20 minutes) or hypertonic saline (5-10 mls/kg over 30 mins). This needs to be given as soon as possible if warning signs occur.

Restrict IV fluids to 2/3 maintenance and replace deficit over 72 rather than 48 hours

Discuss with PICU consultant (if assisted ventilation is required maintain pCO<sub>2</sub> above 3.5 kPa)

Once the child is stable, exclude other diagnoses by CT scan - other intracerebral events may occur (thrombosis, haemorrhage or infarction) and present similarly

A repeated dose of Mannitol should be given after 2 hours if no response

# DKA Intravenous Fluids Calculations

Date: \_\_\_\_\_ Time: \_\_\_\_\_ Age: \_\_\_\_\_

- Must discuss admission & ongoing care with senior on-call medical staff.
- Use Current Measured Weight & Clinic Weight whenever possible.
- Use 10 ml/kg resuscitation bolus. Repeat once if necessary, over 1-2 hrs.
- If further resusc. volume thought necessary (to max. total 30 ml/kg) this must be discussed with on-call ED consultant (DKA signs mimic fluid loss).

Surname: \_\_\_\_\_  
 Forename: \_\_\_\_\_  
 DOB: \_\_\_\_\_  
 HN: \_\_\_\_\_  
 CHI: \_\_\_\_\_

**A. Current Weight:** Measured on Emergency Department arrival (kg):  $\rightarrow$  **A** Current Wt (kg)

**B. % Dehydration:**

DKA Severity	Bicarb (mmol/l)	% Dehydration
Mild	> 10	3
Moderate	5 - 10	6
Severe	< 5	10

$\rightarrow$  **B** Dehydration (%)

**C. True Weight:** Pre-dehydration weight (if known) (if available from a recent clinic: See Magistral \*)  $\rightarrow$  **C** True Weight (kg)

**Est. True Weight:** (using % dehydration)

$$\frac{100 \times \text{A}}{100 - \text{B}} = \frac{100 \times \text{A}}{100 - \text{B}} = \text{C}$$

*Only use if approx. recent clinic weight NOT available.*

**D. Weight Lost:**  $\text{C} - \text{A} = \text{D}$  **D** Weight Lost (kg)

**E. Maint. Fluid Volume:**

Age (yrs)	ml/kg over 48hrs
0 - 2	→ 160
3 - 5	→ 140
6 - 9	→ 120
10 - 14	→ 100
> 14	→ 60

Select ml/kg per 48 hrs according to age (e.g. 160, 140, 120, 100, or 60)  $\rightarrow$  **E** Maint. Fluid Vol. (ml/kg/48hr)

## IV Fluid Rate Calculation

**MAINTENANCE**  $\text{C} \times \text{E} = \text{C} \times \text{E}$  Maintenance (ml/48 hrs)

**DEFICIT**  $\text{D} \times 1000 = \text{D} \times 1000$  Deficit (ml)

**Subtotal 1**  $\text{C} \times \text{E} + \text{D} \times 1000 = \text{Subtotal 1}$  Subtotal 1 (ml/48 hrs)

**MINUS**  $\text{Subtotal 1} - \text{Resusc.} = \text{Subtotal 2}$

**RESUSCITATION** Total Resusc. Fluid Volume (ml)  $\rightarrow$  **Resusc.** Resuscitation (ml)

**Subtotal 2**  $\text{Subtotal 2} \div 48 = \text{Infusion Rate}$  Subtotal 2 (ml/48 hrs)

**INFUSION RATE** (ml/hr)

IV Fluids Start Time: \_\_\_\_\_

IV Insulin Start Time: \_\_\_\_\_ (1-2 hrs after IV Fluid Start)

Calculated by: (Sign) \_\_\_\_\_  
 (Print) \_\_\_\_\_

Checked by: (Sign) \_\_\_\_\_  
 (Print) \_\_\_\_\_

\* Magistral Clinical: <http://ykh-ae:8889/forms90/html>  
 UserName:diabro / Password & Database: obtain from ED staff  
 Read-only access to Magistral Diabetes Clinical Database:  
 access to clinic records - last HbA1c, clinic wt, comments, etc.