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 > 11mmol/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

RHSC Glasgow 2009

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

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

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
>14.9 years	60ml per kg

NB Maintenance calculation is for 48 hours

4. Calculate hourly fluid rate (for 48h)

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

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. It may be preferable therefore to continue with NORMAL saline and added dextrose until the biochemistry is more stable.

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.

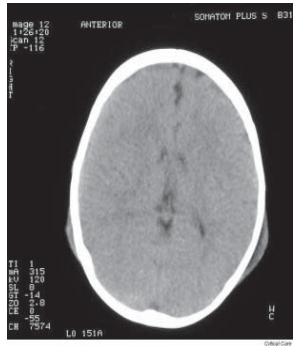
Do not stop the insulin infusion while dextrose is being infused, as insulin is required to switch off ketone production. If the blood glucose falls below 4 mmol/l, give a bolus of 2 ml/kg of 10% dextrose and increase the dextrose concentration of the infusion.

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 - restelessness, 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 pCO2 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

- **Must** discuss admission & ongoing care with senior on-call medical staff.

Surname: _____
Forename: _____
DOB: _____
HN: _____
CHI: _____

Start ← Click Start before data entry or re-entry.

- If needed, use **10 ml/kg** resuscitation bolus.
- Repeat **once,** if needed, over 1-2 hrs**.**

Date: Date

Time: Time Resusc. Fluid Volume: Resusc Vol (ml/kg)

Age: Age (years) Bicarbonate: Bicarb (mmol/l)

A. Current Weight: On arrival in Emergency Department (in kg) → A (A) — Current Weight (kg)

B. % Dehydration:

DKA Severity	Bicarb (mmol/l)	% Dehydration
Mild	> 10	3
Moderate	5 - 10	5
Severe	< 5	8

→ B (B) — Dehydration (%)

C. Estimated True Weight: Pre-dehydration weight

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

→ C (C) — Estimated True Weight (kg)

MINUS

A (A) — Current Weight (kg)

=

D. Weight Lost: Estimated True Weight *minus* Current Weight → D (D) — Weight Lost (kg)

E. Maint. Fluid Volume:

Age (yrs)		ml/kg over 48hrs
Over 48 hours: 0 - 2	→	160
3 - 5	→	140
6 - 9	→	120
10 - 14	→	100
> 14.9	→	60

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

Initial IV Fluid Rate Calculation

MAINTENANCE FLUID: C (C) Est. True Weight (kg) (Pre-dehydration) **x** E (E) Maint. Vol over 48 hrs (ml/kg/48 hrs) → C x E — Maintenance (ml/48 hrs)

PLUS

FLUID DEFICIT: D (D) Weight Lost (kg) **x** 1000 (ml/kg) → D x 1000 — Fluid Deficit (ml)

=

Initial IV Fluids to use: $[Na]^+$ corrected for Glucose = Plasma $[Na]^+$ + (([Gluc] - 5.5) x 0.3)

1. If Glucose ≥ 14 mmol/l → NaCl 0.9%
2. If Glucose < 14 & Corrected $[Na]^+$ < 150 mmol/l → NaCl 0.9% + Dext 5%
3. If Glucose < 14 & Corrected $[Na]^+$ > 150 mmol/l → NaCl 0.45% + Dext 5%

Subtotal 1 — Subtotal 1 (ml/48 hrs)

MINUS

RESUSCITATION FLUID Total Resusc. Fluid Volume (ml) → Resusc. — Resuscitation (ml)

=

IV Fluids Start Time: _____

IV Insulin Start Time: _____

◀ Delay IV insulin start 60-90 minutes **after** IV fluids start. Earlier start increases cerebral oedema risk x 12

Subtotal 2 — Subtotal 2 (ml/48 hrs)

÷ 48 (hrs)

IV Fluid — **IV FLUID INFUSION RATE** (ml/hr)

Calculated by:

(Sign) _____

(Print) _____

Checked by:

(Sign) _____

(Print) _____

Initial IV Insulin Rate Calculation

of 1 unit insulin per ml solution using soluble insulin (e.g. Actrapid)

0.1 units per kg per hour **x** C (C) Est. True Weight (kg) → IV Insulin — **IV INSULIN INFUSION RATE** (ml/hr)