



Clinical Guidelines

Diabetic Ketoacidosis

Document Control Information

Author	M Clement E Randle	Author Position	ANP Consultant
Document Owner	E. Polke	Document Owner Position	Service Coordinator
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1. Assessment

Diagnosis requires a combination of hyperglycaemia, acidosis & ketosis. If all three features are not present then an alternative diagnosis should be considered such as:

Lactic acidosis, inborn error of metabolism, alcoholic ketoacidosis, salicylate poisoning or sepsis.

1.1 History

- Polyuria
- Polydipsia
- Usual insulin regimen (if known diabetes)
- Any triggers (eg. Infections, stress)

1.2 Clinical

- Acidotic breathing pattern
- Abdominal pain / vomiting
- Level of consciousness
 - Assess the GCS
 - Institute hourly neurological observations whether drowsy on admission or not
- Assess & record level of dehydration so that comparison can be made by others later.
 - Mild/Moderate 5% pH >7.1 dry mucous membranes, reduced skin turgor.
 - Severe, 10% pH <7.1 as above + sunken eyes.
 - SHOCKED Rapid thready pulse +/- hypotension.

Do not use capillary refill time alone as an indicator of shock (hypocarbica will cause prolonged capillary refill).

Do not routinely give a fluid bolus to children and young people – **only if signs of shock.**

Give a maximum of 10ml/kg bolus before discussing with senior doctor.

Give an absolute maximum of 30mls/kg. Over estimation of degree of dehydration is dangerous. Most improve with administration of insulin.

1.3 Examination

Look particularly for evidence of

- Infection
- Ileus
- **Cerebral oedema**
 - Headache / Irritability
 - Reduced level of consciousness
 - Bradycardia & hypertension

Cerebral oedema is the most common cause of mortality.

Risk factors for cerebral oedema include

- Severe hypocapnoea at presentation (<2kPa)
- Younger age
- First presentation
- Elevated serum urea at presentation
- Bicarbonate administration
- Rapid fall in corrected sodium (see below)

If suspected discuss with CATS immediately and give:

- Mannitol 20% 0.5g/kg (2.5mls/kg) over 10 – 15 mins **OR**
- Hypertonic Saline 2.7% 3mls/kg over 10 – 15 mins
- Half maintenance fluid rates and discuss with senior medical support or CATS

The aim is to slowly correct metabolic abnormalities

1.4 Indications for discussion with CATS

- pH <7.1 with marked hyperventilation
- Severe dehydration with shock
- Depressed level of consciousness
- Headache
- Age <2yrs.

2. Resuscitation

2.1 Airway & Breathing

- Ensure airway patency
- Intubation is **rarely** necessary. Hyperventilation is a normal compensatory mechanism for metabolic acidosis
- Give 100% oxygen via face mask
- Insert NGT (if decreased conscious level or recurrent vomiting), and leave on free drainage

2.2 Circulation

- Insert 2 IV cannulae
- Take blood samples
 - Blood glucose
 - U&Es (can use electrolytes on blood gas until available)
 - Blood gas (venous gives similar values to arterial)
 - Blood ketones if possible (superior to urine ketones)
 - FBC / BC if sepsis suspected
- Ensure full cardiac monitoring (look for peaked T waves with hyperkalaemia)
- **Do not use capillary refill as an indicator for fluid bolus administration**
 - Hypocarbia causes peripheral vasoconstriction
- **Only if shocked** (tachycardic, poor peripheral pulses +/- hypotension) give 10mls/kg 0.9% saline as a bolus. Assess effect carefully, discuss with senior doctor if considering further fluid bolus - **absolute maximum 30ml/kg total bolus.**
- **Over estimation of dehydration is dangerous.**
- **Do not give bicarbonate.**

3. Management

3.1 Insulin

- There is some evidence that cerebral oedema is associated with early insulin administration.
- Start soluble insulin at 0.05 - 0.1 units/kg/hr 1 hour after starting IV fluids.
- Aim to reduce the blood glucose no faster than 5mmols/hr.
- Once blood glucose <14mmol/l add 5% glucose to IV fluids.
- If blood glucose falls to <4mmol/l give 2mls/kg 10% glucose & increase glucose content of IV fluids to 10%.
- Insulin infusion rate can be temporarily reduced (for 1hr) but should be continued at 0.05 - 0.1 units/kg/hr to switch off ketogenesis.

3.2 Fluids

Requirement = (Maintenance + Deficit (replace over 48hrs)) – any bolus fluid given over the first 20ml/kg

Maintenance requirements (reduced in the August 2015 BSPED guidance)

Weight (kg)	Rate (ml/kg/ 24hrs)
<10 kg	2ml/kg/hour
10-40 kg	1ml/kg/hour
>40kg	40ml per hour

Neonates may require larger volumes.

Deficit (ml) = % dehydration x body weight (kg) x 10

Hourly rate = $\frac{48 \text{ hr maintenance} + \text{deficit} - \text{resuscitation fluids given over the first 20ml/kg}}{48}$

Examples

6yr child weighing 20kg, assessed as moderate DKA with pH 7.15, therefore 5% dehydration who received no saline boluses for resuscitation.

Deficit 5% x 20 kg x10	= 1000ml
Divide over 48 hours	= 21ml/hr
Add maintenance at 1ml/kg/hr	= 20ml/hr
Total	= 41ml/hr

16 yr child 60kg, assessed as severe DKA, pH 6.9, therefore 10% dehydration with circulatory collapse and received 30ml/kg 0.9% sodium chloride boluses.

Deficit 10% x 60kg x 10	= 6000 ml
Subtract resus fluid over 20ml/kg (10ml/kg)	= -600ml
Divide over 48 hours	= 112.5 ml/hr
Add maintenance at 40ml/hr	= 40 ml/hr
Total	= 152.5 ml/hr

3.3 Type of fluid

- 0.9% saline + 20mmol KCL per 500ml (once urine output confirmed).
- Once blood glucose is < 14mmol/l change to glucose containing fluid.
- Calculated deficit replacement fluid must be completed - if tolerating oral fluids, ensure IV rehydration rate is reduced accordingly to account for oral intake.

4. Observations

- Strict fluid balance (catheterise younger patients or those with low GCS)
- Hourly capillary blood glucose measurement
- Hourly BP, HR
- Continuous ECG monitoring
- Half hourly (or more frequently) neurological assessment
- 1-2 hourly capillary blood ketones
- 2 – 4 hourly capillary blood gas & U&Es
- Twice daily weights

5. Troubleshooting

5.1 Acidosis:

If acidosis is not correcting, consider:

- Inadequate fluid resuscitation
- Insufficient insulin to switch off ketogenesis
- Hyperchloraemic acidosis
 - If Cl is >80% of Na
 - Base excess due to $Cl = Na - Cl - 32$

5.2 Corrected Sodium:

Use corrected sodium to assess adequacy of rehydration.

$$\text{Corrected Na} = \text{Measured Na} + 0.4 \times (\text{serum glucose mmol/l} - 5.5)$$

- If Corrected Na **RISING** >5mmol/l in 4hr – indicates too much fluid **LOSS**
Increase fluid rate by 25%
- If corrected Na **FALLING** >5mmol/l in 4hr – indicates too much fluid **GAIN**
Decrease fluid rate by 25%

6. Indication for intubation

- Ventilatory failure
- Loss of airway
- Decompensated shock

Intubation & ventilation poses a significant risk with worsening acidosis due an abrupt rise in pCO₂ . Aim to match pre intubation pCO₂ and allow to rise slowly.

References

- British Society for Paediatric Endocrinology and Diabetes. Recommended DKA guidelines 2015, Julie A Edge.
- NICE guidelines. Diabetes in children and young people: diagnosis and management of type 1 and type 2 diabetes in children and young people. November 2016.