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CoMET Diabetic Ketoacidosis in Children and Young People

This guideline is for use by healthcare staff, at CoMET undertaking critical care retrieval, transport and stabilization of children, and young adults.

CoMET is a Paediatric Critical Care Transport service and is hosted by the University Hospitals of Leicester NHS trust working in partnership with the Nottingham University Hospitals NHS Trust.

The guidance supports decision making by individual healthcare professionals and to make decisions in the best interest of the individual patient.

This guideline represents the view of CoMET, and is produced to be used mainly by healthcare staff working for CoMET, although, professionals, working in similar field will find it useful for easy reference at the bedside.

We are grateful to the many existing paediatric critical care transport services, whose advice and current guidelines have been referred to for preparing this document. Thank You.

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Education and Training

1. Annual Transport team update training days
2. Workshops delivered in Regional Transport Study days/ Outreach

Monitoring Compliance

What will be measured to monitor compliance	How will compliance be monitored	Monitoring Lead	Frequency	Reporting arrangements
Incident reporting	Review related Datix	Abi Hill – CoMET Modern Matron abi.hill@uhl-tr.nhs.uk	Monthly	CoMET Lead Governance Meeting
Colleague Feedback Forms	Feedback Forms Audit	Abi Hill – CoMET Modern Matron abi.hill@uhl-tr.nhs.uk	Monthly	CoMET Lead Governance Meeting

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Risks
Hypokalaemia
Cerebral oedema
Aspiration pneumonia
Inadequate resuscitation

General resuscitation: A, B, C, Suspect Cerebral oedema

1. Clinical history
Polyuria, polydipsia, polyphagia, weight loss, abdominal pain, weakness, vomiting, confusion

2. Clinical signs
Assess dehydration, deep sighing respiration (Kussmaul), lethargy, drowsiness, smell of ketones

3. Biochemistry
Acidemia (pH<7.3 or bicarb <15 and blood ketones >3mmol/L, hyperglycaemia.
Send blood for FBC, CRP, electrolytes, renal function and other investigations if indicated

Confirm diagnosis of Diabetic Ketoacidosis → **Call senior staff**

Shocked patients (Hypotensive and weak pulses)(*CRT not a sign*)
20mL/kg crystalloid (plasmalyte if available) over 15 minutes and reassess.
If shock persists consider further boluses (10mL/kg) up to a total of 40mLs/kg – if still shocked consider inotropes and **CoMET referral**

Do Not Subtract This Volume from Calculated Fluid Deficit

Non-shocked patients
10ml/kg crystalloid (plasmalyte if available) over 60 minutes

This volume should be subtracted from fluid deficit calculation

Calculate Fluid Requirement: Hourly rate = ({Deficit – initial bolus} / 48hr) + Maintenance per hour (See box 1)

Insulin Infusion: after 1-2 hours of IV fluids (See box 2)

Monitoring (continue alongside all steps)
Hourly blood glucose
Neurological status (minimum of hourly)
Hourly fluid input and output
Electrolytes 2 hours after IV therapy start, then 4 hourly
Calculate corrected sodium using lab Na (page 4),
1-2 hourly blood ketones

Neurological deterioration
Headache, Irritability, Slowing HR, Reduced GCS, Specific signs of raised ICP

Exclude hypoglycaemia

Cerebral oedema
Give 5ml/kg of 2.7% NaCl bolus or 5ml/kg mannitol 20% bolus (dose may be repeated if required)
Call senior staff and CoMET referral
Restrict IV fluids by half, NGT to reduce aspiration risk, consider CT head

Intravenous therapy (See box 3)
When blood glucose falls below 14 mmol/L, adjust IV fluids accordingly as directed on table in box 3.
Adjust IV fluid rate based on corrected sodium (see page 3 & 4).

Resolution of DKA
Clinically well, drinking well, tolerating food, blood ketones < 1.0 mmol/L (urine ketones may still be positive) or pH normal

No improvement (pH static/worsening or no reduction in ketones or blood glucose)
Recalculate all IV therapy and infusion rates
Consider sepsis – may require antibiotics
Hyperchloraemic acidosis (calculation page 4)
Discuss further management with CoMET

Insulin
Start subcutaneous insulin
Stop intravenous insulin after 1 hour

Refer to CoMET if:
Cerebral oedema
Hypotension
No improvement
<2 years
Potassium <3.0mmols

DO NOT give bicarbonate correction
DO NOT intubate unless indicated
NO NEED for arterial line or CVL (unless K correction required), use two large cannulas

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Box 1:

Fluid Deficit = % Dehydration x Weight (kg) x 10

pH < 7.2-7.29 &/or bicarb <15 = Mild DKA (5% dehydration)
pH <7.1-7.19 &/or bicarb <10 = Moderate DKA (7% dehydration)
pH <7.1 &/or bicarb <5 = Severe DKA (10% dehydration)

Fluid requirement

< 10kg 100ml/kg/day
10 – 20kg 1000 mls + 50ml/kg for the next 10 to 20 kg
> 20kg 1500 mls + 20ml/kg/day for each additional kilogram above 20kg (maximum 75kg)

Calculating hourly rate

Hourly rate = ({Deficit – bolus} / 48hr) + Maintenance per hour

Do Not Subtract Fluid Bolus' Given For Shock

Rehydrate over 48 hours

Must be calculated and checked separately by two individuals

Box 2:

Insulin infusion

50 units of soluble Actrapid in 50mls of 0.9% NaCl
(50 units of soluble insulin in 49.5mls 0.9% NaCl)
0.05-0.1units/kg/hr starting 1-2 hours after starting IV fluids

- Older children may have a higher insulin requirement)
- <5yrs use 0.05units/kg/hr, severe DKA 0.1units/kg/hr

DO NOT BOLUS
Stop insulin pump, consider continuing long acting s/c insulin if known diabetic

Corrected sodium

Calculate (page 4) 4 hourly alongside laboratory bloods
Try to ensure corrected sodium does not fall with therapy, should rise by 3-5mmol/L in 12 hours

Rise:
>5mmol/L in 4-8 hrs suggests too much fluid loss – increase fluids by 1ml/kg/hr

Fall:
>5mmol/L in 4-8 hrs too much fluid gain – decrease fluids by 1ml/kg/hr

Examples:

20kg non-shocked 5 year old child with pH 7.2 (moderate DKA, 7% deficit) will receive a fluid bolus of 10ml/kg (200ml) over 60 minutes.

Deficit	7% (deficit) x 20 (weight) x 10 = 1400
Fluid requirement	1000 (10kg) + 500 (10kg) + 1500
Hourly rate	1400 (deficit) – 200 (fluid bolus) = 1200 / 48hr = 25ml/hr
	1500 (maintenance) / 24 = 62ml/hr
Total	**25 + 62.5 = 87.5ml/hr total rate**

Laboratory blood results are back

Time	Glucose	Na	K	Cl
0500	41.6	145	5.5	106
0900	27.8	144	5.0	100

Calculate the corrected sodium:
0500: 145 + (41.6 - 5.6) = 145 + 36 = 181 / 3.5 = 51.7
0900: 144 + (27.8 – 5.6) = 144 +22.2 = 166.2 / 3.5 = 47.4

= fall >5mmol/L in 4 hours

Action: decrease fluids and high risk of cerebral oedema

Box 3:

Intravenous therapy: Continuing fluid management

Blood Glucose	Blood Ketones	Insulin Infusion	IV Fluids
> 14 mmol/l	> 3.0 mmol/l	Maintain 0.05-0.1 units/kg/hr	0.9% sodium chloride with 20 mmol potassium chloride in 500ml bag
> 14 mmol/l	< 3.0 mmol/l	Maintain 0.05-0.1 units/kg/hr	0.9% sodium chloride with 20 mmol potassium chloride in 500ml bag
< 14 mmol/l	> 3.0 mmol/l	0.1 units/kg/hr	0.9% sodium chloride with 10% glucose and 20 mmol potassium chloride in 500ml bag
< 14 mmol/l	< 3.0 mmol/l	0.05 units/kg/hr	0.9% sodium chloride with 5% glucose and 20 mmol potassium chloride in 500ml bag
< 6 mmol/l	> 1.0 mmol/l	0.05 units/kg/hr	0.9% sodium chloride with 10% glucose and 20 mmol potassium chloride in 500ml bag
< 4 mmol/l	N/A	Stop for 1 hour	Give 10% glucose bolus 2ml/kg stat. Increase glucose concentration. 0.9% sodium chloride with 10% glucose and 20 mmol potassium chloride in 500ml bag
< 14 mmol/l	< 1.0 mmol/l	Stop infusion after 30 minutes	Clinically well, drinking well, pH normal, start SC insulin

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Name: Date of birth: NHS number:	Date: DKA identified at: Weight: Known diabetic: Y/N

Section	Time (Hourly)
IV Therapy	Rate mls/hr
	Bag 1: 0.9% NaCl & 20 mmol/L KCL
	Bag 2: 0.9% NaCl, 10% Glucose & 20 mmol/L KCL
	Bag 3: : 0.9% NaCl, 5% Glucose & 20 mmol/L KCL
	Total/hr
	Insulin mls/hr
	Insulin units/hr
	Urine Output
Electrolytes and BGs	Glucose
	Ketones
	Sodium (Na)
	Potassium (KCL)
	Chloride (Cl)
	pH / pCO2
	HCO3 / BE
Lab bloods	Urea / Creatinine
	Phosphate
	Corrected Sodium

Calculations:	**Corrected sodium** (mmol/L) = measured sodium + $\frac{(\text{glucose} - 5.6)}{3.5}$	**Hyperchloraemic metabolic acidosis**: Base Excess due to Chloride = (Sodium – Chloride) - 32	**Anion gap** = (Na +k) – (Cl + HCO3)

References

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