University Hospitals of Leicester NHS Trust

Nottingham University Hospitals NHS Trust

CoMET Diabetic Ketoacidosis in Children & Young People

This guideline is for use by healthcare staff, at CoMET undertaking critical care retrieval, transport and stabilisation 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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Approved By:	**UHL Clinical Policy & Guideline Committee**
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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 – Lead Transport Nurse abi.hill6@nhs.net	Monthly	CoMET Lead Governance Meeting
Documentation Compliance	Documentation Audit	Abi Hill – Lead Transport Nurse abi.hill6@nhs.net	3 Monthly	CoMET Lead Governance Meeting

Equality Analysis Assessment

5.1 The Trust recognises the diversity of the staff and local community it serves. Our aim therefore is to provide a safe environment free from discrimination, harassment and victimisation and treat all individuals fairly with dignity and respect and, as far as is reasonably possible, according to their needs.

5.2 As part of its development, an Equality Analysis on this policy have been undertaken and its impact on equality have been reviewed and no detriment was identified.

OR if 5.2 above does not apply seek wording from The Head of Equality on equality@uhl-tr.nhs.uk

EDI Statement

We are fully committed to being an inclusive employer and oppose all forms of unlawful or unfair discrimination, bullying, harassment and victimisation. It is our legal and moral duty to provide equity in employment and service delivery to all and to prevent and act upon any forms of discrimination to all people of protected characteristic: Age, Disability (physical, mental and long-term health conditions), Sex, Gender reassignment, Marriage and Civil Partnership, Sexual orientation, Pregnancy and Maternity, Race (including nationality, ethnicity and colour), Religion or Belief, and beyond.

We are also committed to the principles in respect of social deprivation and health inequalities.

Our aim is to create an environment where all staff are able to contribute, develop and progress based on their ability, competence and performance. We recognise that some staff may require specific initiatives and/or assistance to progress and develop within the organisation.

We are also committed to delivering services that ensure our patients are cared for, comfortable and as far as possible meet their individual needs.

1. Key Words

Diabetes, DKA, Ketoacidosis, Insuilin

CONTACT AND REVIEW DETAILS	
Guideline Lead (Name and Title) **Rebecca Etherington – CoMET Nurse** **Mohammad Zoha – CoMET Consultant**	**Executive Lead** **Andrew Furlong – Medical Director**
Details of Changes made during review: **General formatting update** **Removal of fluids table** **Fluid deficit example recalculated and corrected** **Box added regarding contacting Endocrine**	

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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, blood ketones >3mmol/L, and blood glucose above 11mmol/l. Send blood for FBC, CRP, electrolytes, renal function and other investigations if indicated

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

The BSPED dka-calculator.co.uk can be used to aide fluid calculation

Shocked patients
Tachycardia, weak peripheral pulses, prolonged CRT – hypotension late sign
10mL/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 30 minutes

This volume should be subtracted from fluid deficit calculation

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

DO NOT stop IV insulin infusion whilst on glucose containing fluids. Insulin is required to switch of the production of ketones.

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

Monitoring (continue alongside all steps)
Hourly observations, including BP
Hourly neurological observations (½ hourly if under 2 or pH < 7.1)
Hourly blood glucose, 1-2 hourly ketones
ECG monitoring, observe closely for T wave changes
Hourly fluid input and output
Electrolytes 2 hours after IV therapy started, then 4 hourly
Calculate corrected sodium using lab sodium and NOT from gas (page 4)

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 over 10-15 minutes (dose may be repeated if required)
Call senior staff and CoMET referral ASAP
Restrict IV fluids by half
NGT to reduce aspiration risk
Elevate head and keep midline
Consider CT head (if clinically stable)
DO NOT intubate unless indicated and until experienced doctor available

Intravenous therapy (See Box 1 & 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 (Box 5).

Resolution of DKA
Blood ketones < 1.0 mmol/L (urine ketones may still be positive), clinically well, tolerating oral fluids (no nausea or vomiting).

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 (Box 4)
Discuss further management with CoMET

Insulin
Start subcutaneous insulin as local guidance
Stop intravenous insulin 30-60 minutes after

Refer to CoMET if:
Cerebral oedema
Hypotension
No improvement
<2 years
Potassium <3.0mmol/L

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

Contact Endocrinology as per clinical need

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Box 1: Fluid management

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 (5% dehydration)
pH <7.1 &/or bicarb <5 = Severe DKA (10% dehydration)
(maximum 75kg or 98th centile for age)

Maintenance fluid requirement

100ml/kg/day
1000 ml + 50ml/kg for the next 10 to 20 kg
1500 ml + 20ml/kg/day for each additional kilogram above 20kg
(maximum 75kg or 98th centile for age)

Calculating hourly rate

Shocked patients:
Hourly rate = (Deficit / 48hr) + Maintenance per hour
Non-shocked patients:
Hourly rate = ({Deficit – initial bolus} / 48hr) + Maintenance per hour

Rehydrate over 48 hours
Must be calculated and checked separately by two individuals
The BSPED dka-calculator.co.uk can be used

Box 2: Insulin infusion

50 units of soluble insulin (Actrapid) in 50ml of 0.9% Sodium Chloride (50 units of soluble insulin added to 49.5ml 0.9% Sodium Chloride).

Start at 0.05unit/kg/hr, unless severe DKA or an adolescent then 0.1units/kg/hr should be used. Rates should be adjusted as per parameters in Box 3.

DO NOT BOLUS
Stop subcutaneous (SC) insulin pump
Consider continuing long acting SC insulin if known diabetic

Box 5: Corrected sodium

Calculate 4 hourly alongside laboratory bloods using the below calculation

Corrected sodium (mmol/L) = Measured sodium + ({glucose – 5.6}/3.5)

Alternatively, **the BSPED corrected sodium calculator** can be used at dka-calculator.co.uk/sodium-osmo

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 (too much fluid loss) – can increase fluids
Fall: >5mmol/L in 4-8 hrs (too much fluid gain) – can decrease fluids

Examples:

20kg non-shocked 5 year old child with pH 7.19 will receive a fluid bolus of 10ml/kg (200ml) over 30 minutes

Deficit	5% (deficit) x 20 (weight) x 10 = 1000
Fluid requirement	1000 (10kg) + 500 (10kg) + 1500
Hourly rate	1000 (deficit) – 200 (fluid bolus) = 800 / 48hr = 16.7ml/hr
	1500 (maintenance) / 24 = 62.5ml/hr
Total	**16.7 + 62.5 = 79.2ml/hr total rate**

Time	Glucose	Na	K	Cl
0500	41.6	145	5.5	106
0900	27.8	143	5.0	100

Corrected sodium calculations
0500: 145 + ({41.6 – 5.6}/3.5) = 145 + 10.3 = 155.3
0900: 143 + ({27.8 – 5.6}/3.5) = 143 + 6.3 = 149.3
= 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	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	0.05units/kg/hr or temporarily reduce further for 1 hour if already at 0.05units/kg/hr	Give 10% glucose bolus 3ml/kg stat. Increase to 0.9% sodium chloride with 10% glucose and 20 mmol potassium chloride in 500ml bag* (if not already)
< 14 mmol/l	< 1.0 mmol/l	Stop IV infusion 30-60 minutes after SC	Ketones <1mmol/L, clinical well, tolerating oral fluids

*500ml bags of 0.9% Sodium chloride, 10% Glucose with 20mmol Potassium chloride are NOT readily available premade. They MUST be made up if not immediately available. See BSPED Integrated care pathway for the management of children and young people with Diabetic Ketoacidosis for guidance on preparation (Appendix 3, page 16), available at: Paediatric DKA Integrated Care Pathway 2021

Box 4: Calculations

Anion gap

Anion gap = Sodium – (Chloride + Bicarbonate)

Hyperchloraemic metabolic acidosis

Base Excess due to Chloride = (Sodium – Chloride) – 32

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