

## Management of Electrolyte Imbalance CoMET Guideline

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.

Executive Lead/ Medical Director:	Andrew Furlong - LRI, UHL – <a href="mailto:andrew.furlong@uhl-tr.nhs.uk">andrew.furlong@uhl-tr.nhs.uk</a>
Author:	Owen Clarke – Transport Nurse, CoMET <a href="mailto:owen.clarke@uhl-tr.nhs.uk">owen.clarke@uhl-tr.nhs.uk</a> Shil Patel – PICM ST6 Trainee <a href="mailto:shil.patel@nhs.net">shil.patel@nhs.net</a> Andrew Wignall – Paediatric Critical Care Clinical Pharmacist <a href="mailto:andrew.wignell@nuh.nhs.uk">andrew.wignell@nuh.nhs.uk</a>
Guideline Lead:	Mohammad Zoha, CoMET Consultant <a href="mailto:Mohammad.zoha@uhl-tr.nhs.uk">Mohammad.zoha@uhl-tr.nhs.uk</a>
Clinical Lead: -	Georgina Harlow – CoMET Head of Service <a href="mailto:Georgina.harlow@nuh.nhs.uk">Georgina.harlow@nuh.nhs.uk</a> <a href="mailto:Georgina.harlow@uhl-tr.nhs.uk">Georgina.harlow@uhl-tr.nhs.uk</a>
Approved By:	Policy & Guidelines Committee
Date of Latest Approval:	21 June 2024
Version:	(1)
Next Review Date:	June 2026

### 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 <a href="mailto:abi.hill@uhl-tr.nhs.uk">abi.hill@uhl-tr.nhs.uk</a>	Monthly	CoMET Lead Governance Meeting
Documentation Compliance	Documentation Audit	Abi Hill – Lead Transport Nurse <a href="mailto:abi.hill@uhl-tr.nhs.uk">abi.hill@uhl-tr.nhs.uk</a>	3 Monthly	CoMET Lead Governance Meeting

<b>Hypokalaemia</b>	<b>Clinical signs:</b> ECG changes: U waves, flatter T waves, longer QT, Ventricular tachycardia, Ventricular fibrillation, torsades, include flattening of the T wave, appearance of U waves. Other signs: muscle weakness, ileus, rhabdomyolysis <b>Management:</b> Continuous ECG, Monitor K hourly or after interventions. Ensure hypomagnesaemia is also corrected, as this will assist in the retention of potassium.		
Mild (3-3.5 mmol/L)	<b>Enteral correction</b> (Kay-Cee-L (1mmol/mL liquid) or Sando K (effervescent 12mmol tablets))		
Moderate (2.5-3.0 mmol/L)	<b>Dose:</b> 0.5 - 1mmol/kg	<b>Dilution:</b> n/a	<b>Rate:</b> Twice daily
Severe (< 2.5 mmol/L) and/or symptomatic	<b>Caution:</b> Kay-Cee-L can cause abdominal discomfort, consider Sando-K if gastric distress present		
	<b>IV maintenance:</b> 20mmol potassium chloride in 500ml of fluid for peripheral infusion. 30mmol per 500mL can be given via large peripheral vein. 40mmol in 500mL can be given centrally.		
	<b>IV replacement</b>		
	<b>Dose:</b> 0.4mmol/kg (max 20mL)	<b>Dilution:</b> Dilute to 0.5mmol/mL or less, using sodium chloride 0.9%.	<b>Rate:</b> Give over 1 hour, then re-check potassium.
	<b>Caution: IV Replacement MUST be central and TOTAL maximum rate (including from fluids) of 0.5mmol/kg/hour</b>		
<b>Hyperkalaemia</b>	<b>Clinical Signs:</b> ECG; Peaked T-waves, long PR, flatter/absent P waves, wide QRS, bradycardia, ventricular fibrillation. <b>Management:</b> Stop RBC, infusions, fluids and other medications that increase K. Continuous ECG monitoring and monitor K levels hourly or after interventions.		
Mild 5.5-6.0 mmol/L	<b>Nebulised Salbutamol</b>		
	<b>Dose</b> 2.5mg - 5mg	<b>Dilution:</b> n/a	<b>Rate:</b> PRN
Moderate 6.1-6.9 mmol/L	<b>Insulin/Glucose</b>		
	<b>Dose:</b> 0.1units/kg	<b>Dilution:</b> 10ml/kg of 10% Glucose (or 5mL/kg of 20% glucose centrally only)	<b>Rate:</b> give over 30 minutes
<b>In addition to mild treatments add in moderate treatments.</b>	Check blood sugar 15 and 30 minutes after infusion. Then hourly for six hours. Dose can be repeated after 1 hour.		
	<b>IV Salbutamol</b>		
	<b>Dose:</b> 4microgram/kg (max. 250micrograms)	<b>Dilution:</b> dilute to 50microgram/mL or lower with 5% glucose (Can give undiluted Centrally)	<b>Rate:</b> give over 5 minutes
	Dose can be repeated after 2 hours.		
Severe >7.0 mmol/L and ECG changes are present.	<b>IV Calcium Chloride</b> (10% Min-I-Jet) Solution- give centrally if possible. Can be repeated after 5 minutes if ECG changes persist.		
<b>In addition to mild &amp; moderate treatments add in Calcium to protect heart.</b>	<12 years: 0.2ml/kg (max 10ml)	<b>Dilution:</b> n/a	<b>Rate:</b> 3-5 minutes
	>12 years: 5-10ml		
	<b>IV Calcium Gluconate Injection</b> 10% (0.225mmol/ml)		
	<b>Dose:</b> 0.11mmol/kg (max 6.75mmol)	<b>Dilute</b> to 0.045mmol/ml (Or give neat centrally)	<b>Rate:</b> 5 - 10 minutes (max = 0.5mmol/min)

<b>Hypomagnesaemia</b>	<b>Clinical Signs:</b> Seizures, hypertension, arrhythmias (e.g. Torsades) lethargy, confusion, prolonged PR and QT intervals. <b>Management:</b> Check Mg levels 4 hours post correction. Monitor BP during and after infusion. <b>Caution:</b> May contribute to hypokalaemia and hypocalcaemia. May cause vasodilation/hypotension.		
Mild (0.5-0.7mmol/L)	Prescribe oral supplementation. Caution: Poorly absorbed and may cause diarrhoea.		
Severe (<0.5mmol/L) Or symptomatic	<b>Intravenous Magnesium Sulphate</b> (doses given in terms of both mmol/kg and mg/kg- 1mmol equivalent to 250mg)		
	MMOL <b>Dose:</b> 0.4mmol/kg (Max 20mmol)	<b>Dilution:</b> dilute with sodium chloride 0.9% or glucose 5% to max 0.2mmol/ml peripherally (0.8mmol/ml central)	<b>Rate:</b> Max 2.4mmol/kg/hr OR 36mmol/hour. Giving over 3-6 hours promotes retention. Repeat 12 hourly as needed.
	MG <b>Dose:</b> 100mg/kg (Max 5g)	<b>Dilution:</b> Max 50mg/ml peripheral (200mg/ml central)	<b>Rate:</b> Max 600mg/kg/hr OR 9g/hour. 3-6 hours promotes retention. Repeat 12 hourly as needed.
<b>Hypermagnesaemia</b>	<b>Clinical Signs:</b> weakness, coma, hypotension, bradycardia, heart block. <b>Management:</b> check levels 4 hourly. Monitor BP during IV correction.		
Mg >2mmol/L +/- ECG changes	Give IV Calcium Gluconate ( <b>as per SEVERE HYPERKALAEMIA</b> ) Ensure fluid replete (10ml/kg IV fluid) and encourage diuresis with furosemide (aim for neutral balance)		

<b>Hypocalcaemia</b>	<b>Clinical Signs:</b> Seizures, hypotension, long QT, PEA / VF <b>Management:</b> If IV calcium given too rapidly may cause arrhythmias, hypotension.		
Ionised Calcium	Prescribe oral supplementation (as available locally) If insufficient proceed as follows.		
Aim for 1.0mmol/L	<b>Calcium Gluconate (Maintenance or less urgent)</b>		
If patient on inotropic support, aim 1.2mmol/L	<b>Dose:</b> <1 month: 0.5mmol/kg >1 month: 1mmol/kg (Max 8.8mmol)	<b>Dilute</b> with sodium chloride 0.9% or glucose 5% to 0.045mmol/ml (Can give neat centrally)	<b>Rate:</b> give over 24 hours
	<b>For urgent treatment, give rapid correction with calcium chloride or gluconate SEE TREATMENT FOR SEVERE HYPERKALAEMIA</b> Calcium Chloride or increased dose of Calcium Gluconate can be given.		
<b>Hypercalcaemia</b>	<b>Clinical Signs:</b> Coma, polyuria, hypertension, tachyarrhythmia's. <b>Management:</b> Check levels every 30-60 minutes		
Ionised Calcium (>3mmol/L)	Ensure fluid replete (10ml/kg IV fluid bolus) and encourage diuresis with furosemide (aim for neutral balance)		

<b>Hyponatraemia (Symptomatic)</b>	<b>Clinical signs:</b> Seizures, coma, respiratory depression, restlessness, muscle weakness, fatigue or irritability. <b>Management:</b> Strict fluid balance. Paired measure of urine and serum sodium. Measure Na after interventions 2 hourly via point of care and at least every 4 hours via labs, until >125. Then minimum 12 hourly >125. <b>Caution:</b> Rapid fluid shift can result in osmotic demyelination causing neurological symptoms.		
<130mmol/L	<b>Give isotonic fluid</b> 0.9% Sodium Chloride or Plasma Lyte (with glucose or Potassium as necessary) at full maintenance rate. Oral rehydration solution and foods with high sodium when Na >130 and able. Restrict maintenance rate to 80% if child is euvoelaemic or 2/3s if fluid overloaded.		
<125mmol/L with CNS symptoms	<b>Emergency management:</b> Bolus hypertonic sodium chloride solution = 2.7% or 3% (depending on local availability)		
	<b>Dose:</b> 2ml/kg	<b>Dilution:</b> neat	<b>Rate:</b> give over 30 minutes (10 minutes at consultant discretion)
<b>Hypernatraemia</b>	<b>Clinical signs:</b> Irritability, muscle weakness, coma, lethargy, seizures, hyperreflexia. <b>Management:</b> Check U+E, calcium, magnesium, phosphate and glucose, creatinine and osmolality. Paired Sodium. <b>Caution:</b> Rapid correction of Hypernatraemia can cause haemorrhage, cerebral oedema and neurological injury		
	<b>Reduce excess sodium intake.</b> <b>Assess dehydration</b> and replace deficit over 48 hours with 0.9% Sodium Chloride (or Plasma Lyte) + 5% Glucose (in addition to daily maintenance) <b>Replace ongoing losses</b> ml/ml (excluding urine)		
Rate of sodium change for both Hyponatraemia and Hypernatraemia	<b>Aim to change (increase/decrease) plasma sodium by a maximum of 0.5mmol/L/hour but no more than 8mmol/L per 24 hours</b> <b>This is especially important in hyponatraemia but, can be applied to symptomatic hypernatraemia as well</b>		

<b>Hypophosphatemia</b>	<b>Clinical Signs:</b> Muscle weakness, paraesthesia, cranial nerve palsy, reduced deep tendon reflexes In severe cases, haemolytic anaemia or rhabdomyolysis can occur. <b>Management:</b> Recheck levels one hour post infusion. Repeat correction as necessary up to 1mmol/kg/day (max 70mmol/day)		
Mild / Moderate	Consider oral supplementation. A standard IV bag may be available on request, seek local pharmacist for support.		
Severe (<0.65 mmol/L)	If the above steps are insufficient, IV correction may be necessary. Use 13.6% (1mmol/ml of potassium acid phosphate)		
	<b>Dose:</b> 0.4mmol/kg (max 20mmol)	<b>Dilute</b> 0.1mmol to 1ml via CVL (Maximum peripheral concentration 0.04mmol/mL, diluted with sodium chloride 0.9% or glucose 5%)	<b>Rate:</b> 6 hours
	<b>Caution:</b> Do not exceed 0.05mmol/kg/hour. Hypotension can occur with rapid infusion. Can also potentiate acidosis, hyperkalaemia, hypocalcaemia, renal impairment and oedema. Monitor ECG and BP during IV correction		

## Reference List

R. Isaac, M. Tajik, J. Martin (2021) Birmingham KIDS NTS. **Hyperkalaemia Management Guideline**. [online] Available at: <https://kids.bwc.nhs.uk/wp-content/uploads/2021/02/Hyperkalaemia-Management-Guidelines-KIDS.pdf>

N. Kelly (2016) Birmingham KIDS NTS. **Fluid and Electrolyte Therapy**. [online] Available at: <https://kids.bwc.nhs.uk/wp-content/uploads/2021/02/KIDS-Fluid-and-electrolyte-NK-BF-RI-V1.2.6-FINAL-18July2016.pdf>

Southampton Oxford Retrieval team (2018) Oxford and Southampton Children's Hospital Network. **Electrolyte Replacement Guideline**. [online] Available at: <https://www.sort.nhs.uk/Media/Guidelines/Electrolytereplacementguidelines.pdf>

M. O'Conner, M. D'Souza, A. Abdullahi. (2022) Children's Acute Transport Service. **Hyperkalaemia**. [online] Available at: [https://cats.nhs.uk/wp-content/uploads/cats\\_hyperkalaemia\\_2022.pdf](https://cats.nhs.uk/wp-content/uploads/cats_hyperkalaemia_2022.pdf)

S. Siva, R.Kumar, M. Sharrard, H. Talbot. (2021) EMBRACE. **Neonatal and Paediatric Hyperammonaemia Guideline**. [online] Available at: <https://www.sheffieldchildrens.nhs.uk/embrace/guidelines/>

Knight. D, Mcdougall. M (2022) South Thames Retrieval Service. **Paediatric Critical Care: Electrolyte Emergencies**. Evalina London Clinical Guideline Committee [online] Available at: [Electrolytes 2022 \(evelinalondon.nhs.uk\)](https://evelinalondon.nhs.uk/Electrolytes%202022)