Clinical Guidance

Paediatric Critical Care: Electrolyte Emergencies

Summary

This guidance offers advice for staff treating children in critical care with severe electrolyte derangement until their electrolytes normalise. The advice is for all non-arrest situations and additional advice is included where there is an arrest situation.

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This clinical guideline was produced by the South Thames Retrieval Service (STRS) at Evelina London for nurses, doctors and ambulance staff to refer to in the emergency care of critically ill children. This guideline represents the views of STRS and was produced after careful consideration of available evidence in conjunction with clinical expertise and experience. The guideline does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient.	

Change History		
Date	Change details, since approval	Approved by
Feb 2022	In calcium gluconate box, add info on digoxin. Inserted giving furosemide at same time as seeking to start dialysis in Step 4. Inserted 1 new references (Rafique et al 2019). Hypocalcaemia management updated.	PCGC
Feb 2026	Magnesium sulphate dose adjusted for hypomagnesemia management.	PCGC

Paediatric Critical Care: Electrolyte emergencies

HYPERKALAEMIA (Potassium (K) > 5.5mmol/L +/- ECG changes)

High risk situations:
Tissue destruction (e.g. necrotising fasciitis).
Succinylcholine with tissue destruction or myopathy
Impaired K excretion: e.g. acute renal failure or drugs
Acute haemolysis; massive blood transfusion.

Clinical signs:
ECG changes - simultaneous/progressive: T waves >5mm tall; long PR; flatter/absent P waves; widened QRS; bradycardia/ ventricular fibrillation (**VF**).
Other: muscle weakness; ileus

Management:

STEP 1: Monitoring & medication
Stop red blood cell infusion and other medications & fluids that increase K. Continuous ECG monitoring. If ECG changes present: treat. Do not wait for lab result.
Recheck gas K every 30mins & obtain laboratory confirmation. If any doubt, repeat gas potassium before treating

STEP 2: Calcium Gluconate 10% (CaGlu)
Onset: <2mins
ONLY give if ECG changes
If no ECG changes go to STEP 3
Adverse effects: tissue injury if extravasates

Calcium Gluconate 10% (CaGlu) - ideally central:
0.5mL/kg IV (max 20mL) over 5-10mins
Central: neat. Peripheral: dilute 1mL CaGlu in 4mL 0.9% sodium chloride.
Repeat dose in 5mins if no ECG improvement.
IN ARREST: give immediately, neat, central or peripheral
If on digoxin, check level 6hrs post last dose before giving further digoxin as CaGlu can cause toxicity.

STEP 3:

3a) Insulin & Glucose
Onset: 10-30mins
Adverse effects: hypoglycaemia, hence 10% glucose in 0.9% sodium chloride infusion

Infusions of Insulin & Glucose:
Insulin at 0.05units/kg/h IV (2.5units/kg insulin in 50mL 0.9% sodium chloride at 1mL/h) & 10% glucose in 0.9% sodium chloride at 5-10mL/kg/h IV. Give via the same IV cannula.
Increase insulin to max. 0.2units/kg/h if required. Target blood glucose (BM) ≥6mmol/L with regular BM monitoring.
IN ARREST: first give IV bolus of 0.1units/kg insulin & of 10mL/kg 10% glucose; and then the above infusions.

AND

3b) Beta $_2$ (β_2) stimulants
Salbutamol
Onset: 5-30mins (IV or nebulised).
Do NOT use as monotherapy as 50% unresponsive. AVOID with adrenaline as work on same β_2 receptors.
IN ARREST: **Adrenaline**: Onset: <1min.

Salbutamol: 4micrograms/kg IV over 5mins
Central: neat. Peripheral: dilute to 200micrograms/mL in 0.9% sodium chloride
If self-ventilating: 2.5-5mg nebulised. Repeat PRN.

Adrenaline: 10micrograms/kg IV (0.1mL/kg 1:10 000) neat. Repeat PRN.

STEP 4: Furosemide & Dialysis:
Onset: Furosemide has variable effect on K+ and takes 4-24hrs; Dialysis 1h.
If refractory, start continuous veno-venous Haemofiltration(**CVVH**)/ peritoneal dialysis (**PD**).
Longer CPR appropriate to permit K correction.

Furosemide: Give 1mg/kg IV (10mg max).
Only give if haemodynamically stable; do not delay starting dialysis for this.

HYPOKALAEMIA (K <3.0mmol/L +/- ECG changes)

Clinical signs:

ECG changes: U waves; flatter T waves; long QT; ventricular tachycardia / ventricular fibrillation (**VF**)/ torsades de pointes **(torsades**).
Other signs: muscle weakness; ileus; rhabdomyolysis.

Management: Continuous ECG. Recheck gas K every 30mins. Correct low Mg; hypokalaemia refractory till Mg 0.7-1.0mmol/L.
Central potassium chloride (KCL) 1mmol/kg (max 20mmol) IV over 2h via central line. Dilute in 0.9% sodium chloride to 0.5mmol/mL. Repeat dose until K ≥ 3.0mmol.

ONLY IN ARREST: give KCl neat over 3-5mins, central (IV or intraosseous) or peripheral

HYPERMAGNESAEMIA (Mg >2 mmol/L+/- ECG changes)

High risk situations: admin of Mg; rhabdomyolysis.
Clinical signs: weakness; coma; ↓BP, ↓HR, heart block.
Management: Bolus of CaGlu as above.
Ensure fluid replete (give 10-20mL/kg IV fluid bolus if necessary), then force diuresis with furosemide (1mg/kg IV, max 10mg) & target a neutral fluid balance.
If refractory dialyse. Check Mg level hourly.

HYPOMAGNESAEMIA (Mg <0.6mmol/L +/- ECG changes)

Clinical signs: seizures; ↑BP; arrhythmias (e.g. torsades)
Management: Magnesium Sulphate (**$MgSO_4$**) 50% 100mg/kg (max2g) IV diluted to 100mg/mL in 0.9% sodium chloride over 30mins & after that at 20-50mg/kg/h
If Torsades: $MgSO_4$ 50% 50mg/kg IV (max 2g) immediately & neat
Check Mg level hourly. Target Mg 0.7-1.0mmol/L

HYPERCALCAEMIA (iCa >3mmol/L +/- ECG changes)

High Risk Situations: Malignancy, post rhabdomyolysis.
Clinical signs: coma; polyuria; ↑BP; tachyarrhythmias.

Management:
Ensure fluid replete (give 10-20mL/kg IV fluid bolus if necessary), then force diuresis with furosemide (1mg/kg IV, max 10mg) & target a neutral fluid balance.
If refractory dialyse (CVVH more effective than PD).
Check ionised calcium (iCa) every 30-60mins.

HYPOCALCAEMIA (iCa <0.8mmol/L +/- ECG changes)

Clinical signs: seizures; ↓BP, long QT, pulseless electrical activity (PEA) / VF.
Management:
1. Correct Mg (hypocalcaemia refractory till Mg 0.7-1.0mmol/L)
2. If phosphate (PO_4) <2mmol/L, give CaGlu as above over 1h
3. If **PO_4** ≥2mmol/L, Ca can precipitate-discuss with PICU/renal

IN ARREST: immediately give CaGlu 10% as above.
- Check ionised calcium (iCa) every 30-60mins
- Repeat dose until iCa 1.0-1.4mmol/L

Refs: Rafique et al 2019 Euro Soc of Card 21:A12-19; Effe & Webster 2017 Nephro 22:5-6; Battertink et al 2015 Cochrane Review Issue 10 CD 010344; Mahoney et al 2009 Cochrane Review Issue3; Alfonzo et al 2006 Resus 70:10-25; Evans & Greenberg 2005 J Int Care Med 20:272-90;