

# ELECTROLYTE REPLACEMENT PRESCRIBING - SCH

## PRACTICE GUIDELINE<sup>®</sup>

### DOCUMENT SUMMARY/KEY POINTS

- This guideline is to assist with the prescription and administration of Phosphate, Potassium (enteral only), Magnesium and Calcium replacement in patients who are deficient in these electrolytes
- For intravenous potassium replacement, see [Potassium Policy](#)
- This document is not intended to be used to guide administration of electrolytes in treating specific conditions (ie Magnesium Sulphate for asthma)

### CHANGE SUMMARY

- N/A – New document

### READ ACKNOWLEDGEMENT

The following staff should **read and acknowledge** that they understand the contents of this document:

- All Nursing Staff administering electrolyte replacement
- All Medical Staff involved in prescribing electrolyte replacement
- All Pharmacy Staff

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

<b>Approved by:</b>	SCHN Policy, Procedure and Guideline Committee	
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<b>Team Leader:</b>	Nephrology Fellow	<b>Area/Dept:</b> Nephrology

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## General Prescribing Considerations

- The enteral route should be used for electrolyte replacement where possible.
- Choose a single route of administration (PO or IV) where possible.
- Before prescribing electrolytes, factor in all significant intake, including those from dietary sources, as well as concomitant input from sources such as TPN, during assessment of requirement for supplementation.
- Correction may sometimes be achieved with treatment of the underlying cause and adequate dietary intake without additional supplementation.
- Clinical consideration of compliance with administration as well as assessment of clinical status to ensure adequate gastrointestinal absorption of administered electrolyte replacement is important in deciding route of therapy.
- Consider potential ongoing losses when prescribing electrolytes.
- Serum monitoring should guide further replacement
- Frequency of monitoring will depend on the clinical situation.

## Calcium

### Key Points

- Indications for Intravenous calcium replacement:
  - Symptomatic hypocalcaemia (Tetany, seizures, hypotension, prolonged QT, cardiac arrhythmia, confusion, psychosis)
  - Severe hypocalcaemia (serum level <1.9mmol/L)
  - Unable to take enteral supplements (NBM, post-operative)

### Definition of Hypocalcaemia

Serum concentration Ca <sup>+</sup>	Severity	Recommended 1 <sup>st</sup> line replacement
2.0-2.25mmol/L	Mild	Enteral
1.9-2.0mmol/L	Moderate	Asymptomatic – Enteral Symptomatic – IV
< 1.9mmol/L	Severe	IV

### Conversion

- 1mmol calcium = 40mg elemental calcium

## Formulations Available

	Route	Calcium (elemental)
Calcium Carbonate (Caltrate)	Enteral	15mmol (600mg)
Calcium Carbonate dispersible (Calsource)	Enteral	25mmol (1000mg)
Calcium Gluconate	IV	0.22mmol/ml
Calcium Chloride	IV	0.68mmol/ml

## Enteral replacement

### Dose (expressed as elemental calcium)

- 1mth - 12years = 10-20mg/kg 3-4 times/day
- 12 - 18 years = 250 - 500mg 3-4 times/day (AMH CDC)

## Intravenous replacement

- Doses and dilutions below refer to Calcium Gluconate
- For calcium chloride dosing please refer to Appendix 2 – Intravenous electrolyte dosing table.

### Dose

- Calcium Gluconate - 0.11mmol/kg
- Maximum dose 4.4mmol

### Maximum concentration

- Dilute to 0.11mmol/ml

### Infusion Rate

- Infuse over 60 minutes
- During chemotherapy, administer as per specific chemotherapy protocol
- Intensive care – slow push over at least 3 minutes
- During cardiac arrest – over 10-20 seconds

### Monitoring requirements

- Blood pressure
- Heart Rate

### Adverse effects

- Cardiac – Bradycardia, hypotension

### Considerations

- Administration via large vein recommended. Do not administer via scalp vein, or small hand or foot vein.

- Extravasation can cause necrosis. If extravasation occurs, contact Admitting Medical Officer and consider plastic surgery referral.
- Calcium and Phosphate can precipitate if administered in the same giving set.
- Hypomagnesaemia can cause hypocalcaemia, and the hypocalcaemia can be difficult to correct without normalising the serum magnesium.

## Magnesium

### Key Points

- Indications for intravenous magnesium replacement:
  - Severe hypomagnesaemia (Mg <0.4mmol/L)
  - Symptomatic hypomagnesaemia (Cardiac arrhythmia, seizures, tetany)
  - Unable to tolerate enteral magnesium replacement (ie: NBM, Gastrointestinal upset with enteral supplements)
  - No improvement with enteral replacement

### Definition of Hypomagnesaemia

Serum concentration Mg+	Severity	Recommended 1 <sup>st</sup> line replacement
0.4 – 0.6mmol/L	Mild - Moderate	Enteral
< 0.4mmol/L	Severe	IV

### Conversion

- 1mmol magnesium = 24mg elemental magnesium

### Formulations Available

	Route	Magnesium (Elemental)
Magnesium Aspartate (Magmin)	Enteral	1.55mmol (500mg)
Magnesium Chloride Solution	Enteral	1mmol/ml
Magnesium oxide&phosphate (Blackmores Bio Magnesium)	Enteral	12.5mmol (300mg)
Magnesium Sulphate 50% solution	IV	2mmol/ml

### Enteral replacement

#### Dose (expressed as elemental magnesium)

- 0.1 - 0.2mmol/kg/dose, 2-3 times daily with food
- Increased according to response up to 0.8mmol/kg up to 4 times daily
- (Reference: AMH CDC)

**Side effects**

- Gastrointestinal - Diarrhoea which can be significant and dose-limiting, nausea

**Supply of Magnesium****Inpatient**

- First line formulation of magnesium for inpatients is magnesium aspartate tablets or magnesium chloride liquid.
- For patients with a high tablet burden consider using magnesium oxide & phosphate (Blackmores Bio Magnesium)

For high doses be aware of additional ingredients in Bio Magnesium tablets including calcium, pyridoxine, colexcalciferol, manganese

**Outpatient/Discharge**

- Discharge medications during admissions where initiated – 5 days on discharge. Further supply purchase through local pharmacy without a prescription. For all products except magnesium chloride liquid
- Repeat presentation – nil supply
- Magnesium chloride liquid – not available in external pharmacies therefore supply by SCH.

**Intravenous replacement****Dose**

- 0.1-0.2mmol/kg up to 0.4mmol/kg
- Usual maximum per dose 10mmol

**Dilution**

- Maximum concentration 0.8mmol/ml

**Infusion Rate**

- Infuse over at least 4 hours, Maximum rate = 0.5mmol/kg/hour (SCH injectables)
- In extreme circumstances (eg: Bone Marrow Transplant patients) can be given over shorter period, please consult haematology/ oncology specialist pharmacists/ consultants.

**Monitoring**

- Blood pressure
- Consider cardiac monitoring

**Adverse effects from rapid infusion**

- Cardiac – hypotension, cardiac arrhythmias

- Gastrointestinal - nausea
- Respiratory - respiratory depression

## Phosphate

### Key points

- Intravenous replacement can lead to hyperphosphataemia, which may result in serious complications such as hypocalcaemia, acute kidney injury, and arrhythmias.<sup>1</sup>
- The rise in serum-phosphate concentration cannot be predicted from a given dose.

### Definition of hypophosphataemia

Serum concentration PO <sub>4</sub>	Severity	Recommended 1 <sup>st</sup> line replacement
0.5 – 0.8mmol/L	Mild	Enteral
0.3 – 0.5mmol/L	Moderate	Asymptomatic – Enteral Symptomatic/ventilated – consider IV
< 0.3mmol/L	Severe	IV

### Conversion

- 1mmol = 31mg elemental phosphorous

### Formulations available

	Route	PO <sub>4</sub> <sup>3-</sup>	K <sup>+</sup>	H <sup>+</sup>	Na <sup>+</sup>
Phosphate (Sandoz) effervescent tablet	Enteral	16.1 mmol	3.1 mmol		20.4 mmol
Potassium dihydrogen phosphate 13.6% 10 mL vial	IV	10 mmol	10 mmol	20 mmol	
Sodium dihydrogen phosphate 15.6% 10 mL vial	IV	10 mmol			10 mmol

### Enteral Phosphate Replacement

- Recommended for mild, or asymptomatic moderate hypophosphataemia.

#### Dose

- There are no clear dosing guidelines for paediatric enteral phosphate replacement.
- It is thus suggested to commence enteral replacement at recommended daily intake i.e. approximately 1mmol/kg/day in 2-3 divided doses
- Dose should be adjusted to response, with maximal dose limited by tolerance of enteral therapy.

#### Adverse Effects

- Gastrointestinal - Abdominal pain, nausea, vomiting

- Metabolic - Hyperphosphataemia, hypocalcaemia, hypokalaemia and hypernatraemia
- Renal Nephrocalcinosis (acute phosphate nephropathy) leading to acute renal failure<sup>3</sup>

## Intravenous Phosphate Replacement

- Recommended for severe or symptomatic moderate hypophosphataemia
- First line intravenous replacement potassium dihydrogen phosphate (KH<sub>2</sub>PO<sub>4</sub>)
  - Sodium dihydrogen phosphate (NaH<sub>2</sub>PO<sub>4</sub>) should be considered if:
    - Patient is receiving alternative potassium replacement
    - Avoidance of potassium administration is preferred – renal patients, hyperkalaemia

### Dose

- 0.1-0.36 mmol/kg/day up to 1.5 mmol/kg/day (max 70 mmol/day)
- It is suggested that any single dose greater than 0.36mmol/kg be administered only after consultation with fellow/consultant
- Usual maximum dose 10mmol. Higher doses to be confirmed with fellow/consultant

### Maximum Concentration

- Peripheral - dilute to 0.05 mmol/mL or weaker
- Central - dilute to 0.12 mmol/mL or weaker

### Infusion rate

- Recommended - infuse over 6 hours at a rate of 0.06 mmol/kg/hr or less.
- If necessary, infuse at a maximum rate of 0.2 mmol/kg/hr.<sup>4</sup>

### Monitoring

- Continuous cardiac monitoring, and monitoring of respiratory rate and blood pressure must occur when infused at the maximum rate.
- All patients receiving phosphate replacement must have regular monitoring of renal function and serum calcium, phosphate and potassium.<sup>5</sup>

### Precautions

- Rapid infusion of intravenous phosphate can cause symptomatic hypocalcaemia, hypotension, dysrhythmia and cardiac arrest
- Dose reduce phosphate replacement in renal impairment – If CrCl is <20ml/min reduce dose by 50%
- Do not infuse with magnesium or calcium-containing IV fluids including Total Parenteral Nutrition (TPN).

### Adverse effects

- Cardiovascular – hypotension, dysrhythmia, myocardial infarction, cardiac arrest



- Endocrine/ metabolic – Fluid retention, hyperkalaemia, hypernatraemia. Hyperphosphataemia, hypocalcaemia or hypomagnesaemia.
- Neurological - convulsions, muscle cramps, numbness, tingling, pain or weakness in hands or feet, shortness of breath or troubled breathing, tremor.
- Nephrocalcinosis
- Acute renal failure<sup>6</sup>

## Potassium

### Key points

- For intravenous potassium replacement, see [Potassium Policy](#)
- The primary aim in hypokalaemia is to correct dangerously low potassium concentrations (e.g. < 2.5 mmol/L) to safe levels (>3.0mmol/L), but not to correct the entire deficit immediately.<sup>5</sup>
- The severity of hypokalaemia (based on presence of symptoms) can be used to guide the rapidity and route of correction.

### Definition of hypokalemia

Serum concentration	Severity	Recommended 1 <sup>st</sup> line replacement
3.0-3.5 mmol/L	Mild	Enteral
2.5-3.0 mmol/L	Moderate	Asymptomatic – Enteral Symptomatic patient – consider IV Enteral replacement not feasible- IV
<2.5 mmol/L	Severe	IV

### Conversion

- 1mmol = 39mg potassium

### Formulations available

	Route	Potassium (elemental)
Potassium Chloride Tablet (Slow-K)	Enteral	8mmol
Potassium Chloride 10% solution	Enteral	1.33mmol/ml
Potassium salts (Chlorvescent) -contains chloride/bicarbonate/carbonate	Enteral	14mmol

### Enteral replacement

#### Dose

- The dose is 1-1.5 mmol/kg (maximum 40 mmol/dose) 2-4 times a day.<sup>8, 9</sup>
- A single enteral dose of 2 mmol/kg should never be exceeded.

## Adverse effects

- Gastrointestinal - nausea, flatulence, vomiting, abdominal pains, diarrhoea or bleeding
- Hyperkalaemia occurs only rarely in patients with normal renal function receiving potassium supplements enterally

## Considerations

- In children with asymptomatic chronic hypokalaemia, potassium supplementation may be required indefinitely, especially if the underlying cause cannot be corrected (for example, Type I or II RTA).
- Potassium chloride tends to result in quicker potassium repletion per dose than phosphate or citrate.<sup>6</sup> It is preferred in patients with concomitant hypochloremia or metabolic alkalosis.
- Potassium phosphate may be considered in the setting of proximal tubule dysfunction, such as Fanconi syndrome or cystinosis, where there is loss of both potassium and phosphorus.
- Citrate containing potassium preparations are generally used in children with hypokalaemia and acidosis, as seen in types I and II renal tubular acidosis (RTA).

Potassium salts cause nausea and vomiting. Poor adherence is a major limitation to use and smaller divided doses may minimise gastric irritation.

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## Appendix 1: Enteral Electrolyte Replacement Options

Electrolyte	Brand	Form	Strength	Dose (elemental)
<b>Calcium Carbonate</b>	Caltrate	Tablet	600mg Calcium Carbonate  6mmol elemental Ca	1mth - 12years = 10-20mg/kg 3-4 times/day  12 - 18 years = 250 - 500mg 3-4 times/day
	Ca1000	Effervescent tablet	1g	1mth - 12years = 10-20mg/kg 3-4 times/day
<b>Calcium Gluconate &amp; Chloride</b>	Calsup		25mmol elemental Ca	12 - 18 years = 250 - 500mg 3-4 times/day
	Mag-Sup	Tablet	500mg	0.1 - 0.2mmol/kg/dose, 2-3 times daily with food Increased according to response up to 0.8mmol/kg up to 4 times daily
<b>Magnesium Aspartate</b>	MagMin		1.55mmol elemental Mg	
<b>Magnesium Oxide</b>	Blackmores Bio-Mag	Tablet	300mg	0.1 - 0.2mmol/kg/dose, 2-3 times daily with food Increased according to response up to 0.8mmol/kg up to 4 times daily
			12.4mmol elemental Mg	
<b>Magnesium Chloride</b>	Auspman	Liquid	1mmol/mL elemental Mg	0.1 - 0.2mmol/kg/dose, 2-3 times daily with food Increased according to response up to 0.8mmol/kg up to 4 times daily
<b>Phosphate Salts</b>	Phosphate Sandoz	Effervescent tablet	16.1mmol PO <sub>4</sub>	1mmol/kg/day in 2-3 divided doses  NB: No clear dosing guidelines for enteral phosphate, adjust to response.
<b>Potassium Chloride</b>	Potassium chloride 10% w/v (orion) liquid	Liquid	1.33mmol/mL	1-1.5 mmol/kg (maximum 40 mmol/dose) 2-4 times a day.  Maximum single dose 2 mmol/kg
<b>Potassium Chloride</b>	Slow-K	Slow release tablet	600mg Tablet  315mg elemental K	1-1.5 mmol/kg (maximum 40 mmol/dose) 2-4 times a day.  Maximum single dose 2 mmol/kg
		Cannot be crushed	8mmol elemental K	
<b>Potassium Salts (chloride/bicarbonate/carbonate)</b>	Chlorvescent	Effervescent tablet	14mmol elemental K	1-1.5 mmol/kg (maximum 40 mmol/dose) 2-4 times a day.  Maximum single dose 2 mmol/kg

## Appendix 2. Intravenous Electrolyte Replacement Options

### Electrolyte prescribing in paediatric patients - Intravenous Replacement

Electrolyte	Strength [vial size]	Dose	Diluent*	Max Concentration	Rate
<b>Calcium Gluconate 10%</b>	0.22mmol/mL (100mg/mL) [10 mL]	0.11mmol/kg	Sodium Chloride 0.9% Glucose 5%	0.11mmol/mL (50mg/mL)	Infuse over 60mins Intensive Care: slow push over 3 minutes Cardiac Arrest: 10-20 seconds
<b>Calcium Chloride 10%</b>	0.68 mmol/mL (100 mg/mL) = [10 mL]	0.11mmol/kg	Sodium Chloride 0.9% Glucose 5%	0.136mmol/mL (20mg/mL)	Infuse over 60mins Intensive Care: slow push over 3 minutes Cardiac Arrest: 10-20 seconds
<b>Magnesium Sulphate</b>	2mmol/mL [5 mL]	0.1 to 0.2mmol/kg/dose 0.4mmol/kg/dose  Usual Max per dose 10mmol	Sodium Chloride 0.9% Glucose 5%	0.8 mmol/mL	Standard: 4 hours Fluid restricted: 0.5mmol/kg/hr

\*For further diluents see IV guidelines

For IV potassium see [Potassium Policy](#)

Chart on paediatric intravenous fluid order chart.

Chronic therapy may be charted on paediatric national inpatient medication chart for ongoing therapy eg drug induced electrolyte wasting.

## Appendix 3: Recommended Daily Intake for Electrolytes

- Phosphate:
  - Infant 0-3 years - 10-25mmol/day
  - Child 4-10 years – 25mmol/day
  - Adolescent/Adult – 25-40mmol/day
- Potassium
  - All ages - 2 mmol/kg per day
  - A maximum of 50 mmol/day has been recommended. <sup>1, 2, 3</sup>
  - Magnesium:
    - 0-6 months – 30mg/day
    - 7-12 months – 75mg/day
    - 1-3 years – 80mg/day
    - 4-8 years – 130mg/day
    - 9-13 years – 240mg/day
    - 14-18 years – 410mg/day
- Calcium:
  - 0-6 months – 210mg/day
  - 7-12 months – 270mg/day
  - 1-3 years – 500mg/day
  - 4-8 years – 700mg/day
  - 9-13 years – 1000mg/day
  - 14-18 years – 1300mg/day

The above values are from the Nutrient Reference Values for Australia and New Zealand, accessible at <https://www.nrv.gov.au/>.

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