SESLHD PROCEDURE COVER SHEET

NAME OF DOCUMENT	Electrolyte Replacement (Adults)
TYPE OF DOCUMENT	Procedure
DOCUMENT NUMBER	SESLHDPR/762
DATE OF PUBLICATION	October 2024
RISK RATING	High
LEVEL OF EVIDENCE	National Safety and Quality Health Service Standards: Standard 4 – Medication Safety
REVIEW DATE	April 2026
FORMER REFERENCE(S)	N/A
EXECUTIVE SPONSOR	Director, Clinical Governance and Medical Services
AUTHOR	Quality Use of Medicines, Lead Pharmacist
POSITION RESPONSIBLE FOR THE DOCUMENT	Quality Use of Medicines, Lead Pharmacist SESLHD-DrugCommittee@health.nsw.gov.au
FUNCTIONAL GROUP(S)	Medicine Medicines and Therapeutics Related Policy Documents
KEY TERMS	Potassium, Hypokalaemia, Phosphate, Hypophosphataemia, Magnesium, Hypomagnesaemia, Calcium, Hypocalcaemia, Electrolyte, eFluids, prescribing, dispensing, administration
SUMMARY	Provide guidance to clinicians on the safe and appropriate use of oral and intravenous electrolyte replacement for potassium, phosphate, magnesium and calcium. Describe the products that are available across SESLHD and how to safely prescribe and administer them. Document the expected standard for intravenous electrolyte prescribing and administration in the context of replacement therapy.

1. POLICY STATEMENT

NSW Health Policy Directive PD2024_006 - High-Risk Medicines Management.

The purpose of this procedure is to:

- Provide guidance to clinicians on the safe and appropriate use of oral and intravenous electrolyte replacement for **potassium**, **phosphate**, **magnesium**, and **calcium**.
- Describe the products that are available across SESLHD and how to safely prescribe and administer them.
- Document the expected standard for intravenous electrolyte prescribing and administration in the context of replacement therapy.

2. BACKGROUND

This document has been developed to describe and guide the best practice for electrolyte replacement in adult patients across SESLHD.

This document applies to nursing, pharmacy and medical staff caring for adult patients of the SESLHD.

The following are out of scope:

- Administration of electrolytes to patients in the Intensive Care Unit or Resuscitation Bay of the Emergency Department.
- Administration of electrolytes in emergency conditions such as asthma, cardiac arrhythmia and women with preeclampsia or eclampsia.
- Management of sodium abnormalities is complex and is out of scope for this guideline.
- Electrolyte replacement for neonates, infants, and children refer to specialty guidelines including the Sydney Children's Hospitals Network (SCHN) and Australian Neonatal Medicines Formulary (ANMF).
- Patients with complex alterations in electrolyte balance, acid base status, renal function, or disturbance of other components of plasma. This includes patients receiving parenteral nutrition.

Definitions

Term	Definition
eFluids	The electronic medication management system for fluid orders and drug infusions.
Hyperkalaemia	The condition in which the concentration of potassium in the blood is higher than the normal range.
Hypokalaemia	The condition in which the concentration of potassium in the blood is lower than the normal range.
Isotonic solutions	A solution that has the same ionic strength or tonicity as plasma. A physiological salt solution is one that is isotonic with plasma. Solutions that have the same tonicity will result in no net flow of water across the cell membrane.
IV	Intravenous
MAR	Medication Administration Record
Must	Indicates a mandatory action required by a NSW Health policy directive, law or industrial instrument.
Parenteral	Taken into the body or administered in a manner other than through the digestive tract, as by intravenous or intramuscular injection.
Premixed intravenous solutions	Intravenous admixtures prepared in a regulated compounding facility with full labelling and expiry dating (e.g. centralised IV admixture service, commercial GMP licensed facility).
Should	Indicates an action that should be followed unless there are sound reasons for taking a different course of action.

3. RESPONSIBILITIES

Role	Responsibilities
Medical Officers (MO)	• Understands and implements the principles of safe prescribing of electrolytes • Escalate any adverse events relating to electrolytes
Registered Nurses (RNs)	• Understand and implement the safe practice of administration of electrolytes • Escalate any adverse events relating to electrolytes
Enrolled Nurses (ENs without a notation)	• Understand and implement the safe practice of administration of oral and checking of intravenous electrolytes, but NOT administration of intravenous electrolytes. • Practice within the scope outline in the SESLHDPD/160 Medication: Administration by Enrolled Nurses. • Escalate any adverse events relating to electrolytes
Pharmacists	• Understand and implement the safe practice of prescribing, dispensing, storage and administration of electrolytes • Escalate any adverse events relating to electrolytes
Nurse Unit Managers (NUM)	• Ensure this document rule is available to all staff and ensure staff compliance • Understand and implement the safe practice of storage of electrolytes • Ensure potassium preloaded bags and vials (where applicable) comply with the storage requirements outlined in NSW Health Policy Directive PD2024_006 - High-Risk Medicines Management.
SESLHD Managers	• Establish a clinical governance structure to ensure safe use of Potassium (intravenous) in accordance with NSW Health Policy Directive PD2024_006 - High-Risk Medicines Management. • Monitoring and review of incidents associated with electrolyte replacement

4. PROCEDURE

Disturbances in electrolyte concentrations have diverse clinical presentations. They may be asymptomatic and detected incidentally. Measuring serum sodium, potassium, calcium, magnesium, and phosphate concentrations is usually warranted in patients who present with:

- symptoms suggestive of electrolyte abnormalities (e.g., tetany)
- circulation, cardiac rhythm, hydration, conscious state, urine output or neuromuscular function disturbances
- bowel, kidney, respiratory or liver function abnormalities.

Electrolyte disturbances that are difficult to treat often indicate significant disease or coexisting ion disturbances. Seek expert advice.

Rapid administration of electrolytes or correction of severe derangements may result in cardiac arrhythmias – ensure that the required cardiac monitoring is available if required. An appropriate area of care should be considered when 4-6 hourly monitoring is required.

Electrolytes **MUST** be written in FULL. Chemical abbreviations **MUST NEVER** be used e.g., potassium chloride - NOT KCl

Orders for intravenous electrolytes **MUST**

- be expressed in millimoles (mmol) not milligram per litre (mg/L) or percent (%).
- have the rate, route, dilution and administration instructions fully specified on the intravenous infusion medication chart.

Orders without instructions for dilution and infusion rate are not complete and **MUST NEVER** be used for either dispensing or administration.

Advance orders charted across multiple days will not be accepted. A new order **MUST** be written each day after assessment of the patient's serum electrolyte levels.

The infusion rate or time period **MUST** be included. Orders **MUST NEVER** contain directions to give intravenous electrolytes as a 'bolus 'or 'stat' dose.

Electrolyte solutions are incompatible with blood products, some medications and often each other. Refer to the Australian Injectable Drugs Handbook or seek advice from pharmacy services before mixing together in an infusion or giving simultaneously via the same IV line.

Jump to:

- **POTASSIUM**
- **PHOSPHATE**
- **MAGNESIUM**
- **CALCIUM**

4.1. POTASSIUM

4.1.1. High-risk Medication – Potassium (intravenous)

The administration of intravenous (IV) potassium is a potentially dangerous procedure:

- Errors in calculation or admixture of concentrated potassium-containing solutions can result in serious adverse reactions, including **fatal** bradycardia, asystole and ventricular fibrillation.
- IV bolus administration of concentrated potassium can be lethal.
- When high concentrations are used, even minor divergence from the recommended rate of administration can be cardiotoxic.

The expected standard of practice is to prescribe pre-mixed potassium containing infusion bags. There are pre-mixed bags available to suit almost all clinical situations and it is **MANDATORY** for these to be considered as the first option.

4.1.1.1. Prescribing

The following eFluids order sentences have been developed to assist in the safe prescribing of intravenous potassium:

- potassium chloride 10 mmol in sodium chloride 0.29% intravenous solution 100 mL, IV Continuous Infusion, **100 mL/hr**
- potassium chloride 30 mmol in glucose 4% with sodium chloride 0.18% intravenous solution 1000 mL, IV Continuous Infusion *(rate not specified)*
- potassium chloride 30 mmol in sodium chloride 0.9% intravenous solution 1000 mL, IV Continuous Infusion *(rate not specified)*

4.1.1.2. Administration

When a patient is ordered an intravenous potassium solution, commercially prepared pre-mixed intravenous potassium chloride solutions **MUST** be used wherever possible.

Preparation of a non-standard potassium containing solution for intravenous infusion is a high-risk process and not recommended due to the following risks:

- Errors in calculation of potassium additive, leading to confusion regarding the final concentration.
- Inadequate mixing of potassium and infusion, leading to pooling of the potassium additive and inadvertent potassium bolus.

Additional potassium chloride **MUST NEVER** be added to a pre-mixed potassium bag and **MUST NEVER** be added to hanging or running IV bags. Potassium **MUST NEVER** be added to a burette.

If commercially prepared pre-mixed intravenous potassium chloride solutions are not suitable and concentrated IV potassium has been added to a fluid solution, the bag contents **MUST** be mixed well (by inverting and agitating) to ensure even distribution of potassium in the solution and labelled in accordance with the National Standard for User-applied Labelling of Injectable Medicines, Fluids and Lines.

A rate limiting device such as an infusion pump **MUST** be used for all potassium containing infusions. Wherever possible this should be a 'smart' pump using a pre-programmed infusion protocol. Dose error reduction software, where implemented, must be turned on and not bypassed while potassium is being infused.

A second person check is required for the administration of all intravenous potassium solutions. Attach a label to the infusion device and intravenous line stating: **"Potassium do not bolus".**

Ensure the infusion of IV potassium chloride is delivered via its own lumen with no other infusions or connections in the line. Giving other drugs via Y-site may change the infusion rate of potassium.

Extravasation may cause severe complications. Pain or phlebitis may occur during administration of solutions containing greater than 30 mmol/L of potassium.

- The vascular access device patency must be checked prior to administering potassium- containing fluids, and the **peripheral cannula site should be directly visible throughout the infusion for monitoring for phlebitis/extravasation.**
- Assess infusion site frequently for pain and phlebitis, which occur more frequently with higher concentrations and when administered via a small vein.
- Patients should be educated to report pain, stinging or leakage from the peripheral IV cannula.
- If any of these occur the infusion should be paused for assessment of cannula patency and a replacement IV cannula inserted if indicated.

4.1.1.3. Storage

The standards for storage of intravenous potassium are described NSW Health Policy Directive PD2024_006 - High-Risk Medicines Management.

4.1.2. Potassium Replacement Recommendations

Serum Potassium levels below 3 mmol/L may result in arrhythmias. *See Monitoring Requirements in Table 1.*

Check magnesium levels – repletion of magnesium stores will facilitate more rapid correction of hypokalaemia.

Intravenous potassium replacement must only occur when the oral route is unavailable or will not achieve the required elevation of serum potassium within a clinically acceptable timeframe.

Note: Patients with diabetic ketoacidosis and significant renal impairment have extremely complex potassium requirements and expert advice / management is required.

Table 4.1.2: Potassium Replacement Recommendations			
Serum Potassium	**Route**	**Potassium Dosage**	**Monitoring Required**
Mild Deficit: Serum Potassium: 3.1 – 3.5 mmol/L	Oral	• Potassium chloride 600 mg (potassium 8 mmol) modified release tablets: 2 tablets (16 mmol potassium) BD or TDS **OR** • Potassium effervescent tablets: 1-2 tablet (14-28 mmol potassium) BD or TDS	Daily serum potassium ECG not required
Moderate Deficit: Serum Potassium: 2.5 – 3.0 mmol/L	Oral (preferred)	• Potassium chloride 600 mg (potassium 8 mmol) modified release tablets: 3 tablets (24 mmol potassium) TDS **OR** • Potassium effervescent tablets 2-3 tablets (28-42 mmol potassium) TDS	Serum potassium at least every 6-12 hours ECG is required if symptomatic (arrhythmia, marked muscle weakness or rhabdomyolysis)
	AND / OR		
	IV	**IV Peripheral Line** (maximum rate 10 mmol/hr) • 30 mmol potassium chloride in 1000mL pre-mixed bag **OR** • 10 mmol potassium chloride in 0.29% sodium chloride (isotonic) pre-mixed bag (100mL)	
Severe Deficit: Serum Potassium: Less than 2.5 mmol/L	Oral	• Potassium chloride 600 mg (potassium 8 mmol) modified release tablets: 3 tablets (24 mmol potassium) TDS **AND/ OR** • Potassium effervescent tablets 2 tablets (28 mmol potassium) TDS	Serum potassium every 4-6 hours ECG required
	AND		
	IV	**IV Peripheral Line** (maximum rate 10 mmol/hr) • 10 mmol potassium chloride in 0.29% sodium chloride (isotonic) pre-mixed bag (100mL)	
		OR	
		IV Central Line (rate not to exceed 20 mmol/hr without continuous ECG monitoring) • 10 mmol potassium chloride in 0.29% sodium chloride (isotonic) pre-mixed bag (100mL)	

Note: Information on the use of potassium acetate is not included in this guideline. This should only be used for potassium replacement in critical care areas.

4.1.3. Available Oral Supplements

Gradual replacement of potassium (via oral route) is preferred, if clinically appropriate since the relatively slow absorption from the gastrointestinal tract prevents sudden large increases in plasma potassium concentrations.

If a patient is fluid restricted, **ALWAYS** consider giving potassium via the oral route.

Table 4.1.3: Available Oral Supplements

Potassium Product	Potassium content	Brand Names	Comments
Modified release tablet	8 mmol (600 mg)	Span K®	Swallow whole, do not crush, chew or suck tablets Swallow tablets with a full glass of water whilst sitting upright Take with or after food to lessen chance of stomach upset
Effervescent tablets	14 mmol	Chlorvescent® (Dissolve in 100 - 150 mL water)	Dissolve tablets completely in half to one glass of cold water Take with or after food to lessen the chance of stomach upset
Oral mixture	20 mmol (1.5g) in 15mL	Potassium chloride Oral Mixture 10% w/v®	

Note: Potassium citrate products are also available but are indicated for the prevention of kidney stones and increasing urine pH.

4.1.4. Available Pre-mixed Potassium Bags for Intravenous Infusion (Adults)

The pre-mixed potassium bags for intravenous infusion available in SESLHD are packaged in PINK over-pouches and clearly labelled with the potassium content in millimoles (mmol) per final volume. They MUST be separated from other, same size, commercial intravenous solutions (e.g., sodium chloride 0.9%) to avoid selection errors.

Table 4.1.4: Available Pre-mixed Potassium Bags for Intravenous Infusion (Adults)

Potassium (mmol)	Fluid	Volume	Order From
10	0.29% sodium chloride (isotonic)	100 mL*	Pharmacy
30	0.18% sodium chloride and 4% glucose	1000 mL	One Link
	5% glucose	1000 mL	
	Hartmann's solution	1000 mL	
	0.9% sodium chloride	1000 mL	
40	0.9% sodium chloride	100 mL¥	

**The isotonic formulations contain a different concentration of sodium chloride to the other pre-mixed bags. This enables safe peripheral administration. The same concentration cannot be made with normal saline (sodium chloride 0.9%) bags.¥ For use via a central line in critical care units.*

Note:

- Information on using potassium dihydrogen phosphate should be reserved for phosphate replacement and can be found in the Phosphate section of this document.
- 0.9% sodium chloride is the preferred infusion fluid as 5% glucose may cause trans-cellular shift of potassium into cells.
- Monitor the injection site closely due to the risk of phlebitis.

4.1.5. Potassium Ampoules available from SESLHD Pharmacy Services

- Supply of potassium ampoules as imprest is restricted to the below locations.
- Potassium ampoules must be physically separated from ampoules of similar appearance and packaging, for example, in a separately identified and coloured box, and retained in original packaging until immediately prior to use. Label with "**Concentrated potassium MUST be diluted before use**". The aim of this is to alert users to the contents and minimise cognitive mix-up.
- All staff must refer to the standards for storage and supply of intravenous potassium stated in the NSW Health Policy Directive PD2024_006 - High-Risk Medicines Management.
- Clinical areas which have automated drug cabinets (ADCs), potassium ampoules must be stored in a secured pocket (Cubie) within the ADC.

Table 4.1.5: Potassium Ampoules available from SESLHD Pharmacy Services

Locations	Potassium chloride	Potassium dihydrogen phosphate	Potassium Acetate¥
	10 mmol Potassium per 10 mL		
POWH	Cardiothoracic ICU, Cardiothoracic Operating Theatre, Intensive Care, Emergency, Medical Imaging, Operating Suite, P9W Renal Unit	Cardiothoracic ICU, Intensive Care, Operating Suite	Cardiothoracic ICU, Intensive Care,
SGH	Intensive Care, Emergency, Theatre, Recovery, SCN2, Renal & Dialysis Unit	Intensive Care, Emergency, 2 South*	Intensive Care
TSH	Critical Care Medicine (CCM), Coronary Care Unit, Emergency, Theatre, Recovery, Special Care Nursery	Intensive Care, Emergency,	Pharmacy ONLY
RHW	Close Observation Unit, Newborn Care Centre, Maternal Fetal Medicine	Close Observation Unit	Close Observation Unit
SSEH	Emergency, Theatre	Pharmacy ONLY	Pharmacy ONLY
*Peritonectomy patients			
¥ Information on the use of potassium acetate is not included in this guideline. This should only be used for potassium replacement in critical care areas.			

4.1.6. Monitoring

- The normal range of serum potassium is 3.5 to 5.2 mmol/L. Careful monitoring of serum potassium levels during administration and appropriate adjustment of dosage is essential.
- It is the responsibility of the patient's medical team for ordering the appropriate blood test(s) and checking results as clinically indicated.
- Electrolyte disturbances that are difficult to treat often indicate significant disease or coexisting ion disturbances. Seek expert advice.
- A blood specimen should be drawn and sent for electrolyte, urea and creatinine (EUC) levels as clinically indicated for each patient who has been administered potassium replacement therapy.
- Susceptible patient groups, at higher than usual risk of inappropriate elevation of potassium levels, require close monitoring of EUCs. These include patients with renal impairment, and those on certain medications e.g., spironolactone, ACE inhibitors and angiotensin 2 receptor antagonists, which may cause potassium retention.
- If an urgent serum potassium level is required, a venous blood sample may be sent to pathology in a blood gas syringe. Levels of urea and creatinine cannot be provided in this option.
- Cease potassium administration and notify MO if serum potassium is ≥ 5.2 mmol/L or signs / symptoms of hyperkalaemia are identified.

Table 4.1.6: Signs / Symptoms of Hyperkalaemia

Symptom	Observation
Muscle weakness	Flaccid muscles, Respiratory distress (from weakened breathing muscles)
Changes in affect	Irritability, Anxiety
Hyperflexia	Twitching, Paraesthesia
Hyperactivity of smooth muscles	Intestinal colic, Abdominal cramping, Diarrhoea, Nausea and Vomiting.
Decreased cardiac contractility	Tachycardia *early*, Bradycardia *later*, Heart Block, Palpitation, Ventricular fibrillation, Cardiac Arrest
ECG Changes	Peaked, narrow T wave; Prolonged PR interval, Disappearance of P wave, Widened QRS interval
Renal signs	Oliguria, Anuria

Note: different thresholds apply in the treatment of Diabetic Ketoacidosis (DKA) or Hyperglycaemic Hyperosmolar State (HHS). Seek expert advice.

- Collection of the specimen from the same arm as the potassium infusion should be avoided and the opposite arm should be used. Where there is no other option, the infusion must be paused with a minimum wait time of 2 minutes prior to performing venepuncture.

4.2. PHOSPHATE

4.2.1. General Information

4.2.1.1. Prescribing

The following eFluids order sentences have been developed to assist in the safe prescribing of intravenous phosphate:

- **potassium** dihydrogen phosphate 10 mmol in sodium chloride 0.9% intravenous solution 275 mL, (rate)
- **sodium** dihydrogen phosphate 10 mmol in sodium chloride 0.9% 250 mL, IV infusion, (rate)

4.2.2. Replacement recommendations

There are no national guidelines for the treatment of acute hypophosphataemia and practice varies widely across Australian hospitals. The use of phosphate for other indications such as re-feeding syndrome or use in the critical care setting is out of scope for this document and, specialist advice should be sought.

Concomitant hypocalcaemia should also be corrected before treating hypophosphataemia to prevent further hypocalcaemia.

Serum Phosphate	Route	Phosphate Dosage	Monitoring Required
Mild Deficit: Serum Phosphate: 0.5 - 0.75 mmol/L	Treatment not usually required as can be treated by increasing dietary intake of food high in phosphate (e.g. dairy products), except if alcoholism/ withdrawal, malnutrition, re-feeding syndrome, receiving TPN, renal phosphate wasting, recovery from DKA or respiratory failure.		
Moderate Deficit: Serum Phosphate: 0.3 - 0.49 mmol/L	Oral	• Effervescent phosphorus tablet 500 mg* (Phosphate Sandoz®): 1- 2 tablets (16.1 – 32.2 mmol phosphate) up to TDS **Dose may be limited by diarrhoea*	Daily Serum phosphate & calcium
	OR if symptomatic		
	IV	**IV Peripheral Line** Administer over 2 - 6 hours • 10 mmol **potassium** dihydrogen phosphate in 0.9% sodium chloride pre-mixed bag (275 mL) **OR** • 10 mmol **sodium** dihydrogen phosphate in 250 mL 0.9% sodium chloride	
Severe Deficit: Serum Phosphate: Less than 0.3 mmol/L	IV	**IV Peripheral Line** Administer over 2 hours • 10 mmol **potassium** dihydrogen phosphate in 0.9% sodium chloride pre-mixed bag (275 mL) **OR** • 10 mmol **sodium** dihydrogen phosphate in 250 mL 0.9% sodium chloride	Serum phosphate & calcium every 6-12 hours

4.2.3. Available Oral replacement

Phosphate Product	Phosphate content	Brand Names
Effervescent tablets*	16.1 mmol (500 mg)	Phosphate Sandoz®

** Tablet should be dissolved in approximately 75 mL of water and taken orally.*

4.2.4. Available intravenous replacement

Form	Electrolyte Content	Availability
Potassium dihydrogen phosphate in 0.9% sodium chloride pre-mixed bag (275 mL)	**10 mmol potassium** 10 mmol phosphate	Select clinical wards and Pharmacy.
Sodium dihydrogen phosphate in 10 mL vial	**10mmol sodium** 10mmol phosphate	Select clinical wards and Pharmacy.
Potassium dihydrogen phosphate in 10 mL vial	**10 mmol potassium** 10 mmol phosphate	**Critical care areas** and Pharmacy, see Table 4.1.4 for details.

4.2.5. Monitoring

- The normal range of serum phosphate is 0.8 to 1.5 mmol/L. Careful monitoring of serum phosphate, calcium, potassium and sodium levels, as well as renal function, during administration and appropriate adjustment of dosage is essential.
- It is the responsibility of the patient's medical team for ordering the appropriate blood test(s) and checking results as clinically indicated. Electrolyte disturbances that are difficult to treat often indicate significant disease or coexisting ion disturbances. Seek expert advice.
- A blood specimen should be drawn and sent for electrolyte, urea, and creatinine (EUC) levels as clinically indicated for each patient who has been administered phosphate replacement therapy.
- Monitor for signs of tetany i.e., muscle cramps, spasms, or tremors as this may indicate hypocalcaemia.
- Thirst, fever, tachycardia, confusion, and irritability may be signs of excessive sodium replacement.
- Monitor for signs and symptoms of hyperkalaemia – nausea, confusion, weakness, slow or irregular heart rate, and numbness or tingling of the lips, hands or feet.

4.3. MAGNESIUM

4.3.1. General Information

4.3.1.1. Prescribing

The following eFluids order sentences have been developed to assist in the safe prescribing of intravenous magnesium:

- magnesium sulfate 10 mmol in sodium chloride 0.9% 100 mL, IV infusion, over 1 hour

4.3.2. Replacement recommendations

Hypomagnesaemia is common in hospitalised patients, especially those who are severely ill. It is usually due to gastrointestinal or kidney loss, often on a background of diabetes, alcoholism, diuretic drug therapy, malabsorption syndromes or poor oral intake. Correcting the cause, when possible, is the mainstay of treatment.
Patients with symptomatic severe magnesium deficit may require escalation of care. Discuss with a Senior Medical Officer.

Serum Magnesium	Route	Magnesium Dosage	Monitoring Required
Mild to Moderate Deficit: Serum Magnesium: 0.4 – 0.7 mmol/L	Oral	• Magnesium aspartate (500 mg)* 1 to 2 tablets (1.54 – 3.08 mmol) BD. Up to 6 tablets (9.24mmol) daily in divided doses may be required (e.g., 2 tablets TDS). **Dose may be limited by diarrhoea*	Daily or second daily serum magnesium
Severe Deficit: Serum Magnesium: Less than 0.4 mmol/L **OR** Symptomatic (e.g. tremor, weakness, cardiac arrhythmias, convulsions)	IV	**IV Peripheral Line** • 10 to 20 mmol magnesium sulphate ($MgSO_4$) in 100mL 0.9% sodium chloride over 1 hour*. Repeat if necessary, at 4 hourly intervals according to response. **Maximum infusion rate 36 mmol/hour.*	Serum magnesium levels or clinical symptoms within 6 to 12 hours.

Note: Hypomagnesemia may cause concomitant refractory hypokalaemia and hypocalcaemia, ongoing monitoring and replacement of all electrolytes is required

4.3.3. Available Oral replacement

Form	Approved Name	Magnesium content	SESLHD Restriction
Tablet	Magnesium aspartate*	500mg (1.54mmol per tablet)	n/a
Oral solution	Magnesium Chloride	1mmol/mL (100mL)	Restricted for paediatric patients with narrow bore NG/PEG tubes.

**Poor oral absorption*

4.3.4. Available intravenous replacement

Form	Electrolyte Content	Availability
Magnesium sulphate ($MgSO_4$) 2.5 g/ 5mL concentrated ampoule	10 mmol magnesium sulphate in 5 mL	Vial available in Pharmacy and after-hours drug cupboard.
Magnesium sulphate ($MgSO_4$) 5 g/ 10mL concentrated ampoule	20 mmol magnesium sulphate in 10 mL	

4.3.5. Monitoring

- The normal range of serum magnesium is 0.8 to 1.1 mmol/L.
- Hypomagnesaemia (Magnesium level < 0.8 mmol/L) usually remains asymptomatic until the levels drop below 0.5mmol/L and is commonly associated with other metabolic abnormalities such as hypokalaemia, hypocalcaemia, and metabolic acidosis. A level <0.4mmol/L indicates severe deficiency.
- Careful monitoring of serum phosphate, calcium, potassium and sodium levels, as well as renal function, during administration and appropriate adjustment of dosage is essential.
- It is the responsibility of the patient's medical team for ordering the appropriate blood test(s) and checking results as clinically indicated. Electrolyte disturbances that are difficult to treat often indicate significant disease or coexisting ion disturbances. Seek expert advice.
- A blood specimen should be drawn and sent for electrolyte, urea, and creatinine (EUC) levels as clinically indicated for each patient who has been administered magnesium replacement therapy. If repeated doses of IV magnesium are required for severe deficit, the serum magnesium concentration should be monitored every 1 to 2 hours initially.
- Lower doses of magnesium are required in kidney impairment. Close monitoring is especially important in this patient population.

4.4. CALCIUM

4.4.1. General Information

4.4.1.1. Prescribing

The following eFluids order sentences have been developed to assist in the safe prescribing of intravenous calcium:

- calcium gluconate 2.2 mmol in sodium chloride 0.9% 100 mL, IV infusion, **over 20 minutes**

Note: Calcium gluconate is preferred to calcium chloride as it is less toxic to peripheral veins.
Note: Calcium Chloride is restricted to use in critical care areas for treatment of hyperkalaemia in emergency situations.

4.4.1.2. Administration

Note: Extravasation of calcium can cause localised skin necrosis. Calcium should never be administered by intramuscular or subcutaneous injection.

4.4.2. Replacement recommendations

Routine investigations for hypocalcaemia should include parathyroid hormone (PTH) and 25-OH vitamin D. Corrected calcium (cCa) should be used to monitor hypocalcaemia rather than total calcium. Another option is to measure functional (ionised) calcium . Hypomagnesemia should also be corrected, as hypomagnesaemia can induced end-organ PTH resistance and/or suppress PTH secretion. Correct vitamin D deficiency while treating hypocalcaemia.

Patients with symptomatic or severe calcium deficit may require escalation of care. Discuss with a Senior Medical Officer.

Serum Calcium	Route	Calcium Dosage	Monitoring Required
Mild Deficit: Serum corrected calcium: 1.90 - 2.10mmol/L	Oral	• Calcium carbonate 1500 mg (elemental calcium 600 mg) 2 tablets (15-30mmol) BD. *Dose can be increased every 1 – 2 days to a maximum daily dose of 7200 mg elemental calcium in 2 -3 divided doses.* • Calcitriol 0.25 microg BD. *Dose can be increased to a maximum dose of 0.5 microg BD.*	Check serum electrolytes/ urea/ creatinine (EUC), PTH, 25-OH-VitD concentrations before commencing treatment. Perform 12-lead ECG to screen for prolonged QTc interval. Perform CMP daily (or at MOs discretion).
Severe Deficit: Serum corrected calcium: Less than 1.9 mmol/L **OR** **Symptomatic hypocalcaemia** Serum corrected calcium: > 2.10 mmol/L **AND** patient has severe clinical features (e.g. tetany, carpopedal spasm, laryngospasm, bronchospasm, seizures) **or** ECG changes of hypocalcaemia.	IV	**IV Large Peripheral Vein or Central Line** • Calcium Gluconate 10% (10 mL vial) 1 to 2 vials (2.2 to 4.4 mmol) in 100 mL 0.9% sodium chloride over 20 to 30 minutes **THEN** • Calcium Gluconate 10% (10mL vial) 10 vials (22 mmol) in 900 mL 0.9% sodium chloride at 50 mL/hour	Check serum electrolytes/ urea/ creatinine (EUC), PTH, 25-OH-VitD concentrations before commencing treatment. Perform 12-lead ECG to screen for prolonged QTc interval. Contact Endocrinology (and Intensive Care or Cardiology if ECG changes). Repeat serum calcium at the end of the infusion.

4.4.3. Available Oral replacement

Calcium Product	Calcium content	Brand Names
Calcium Carbonate tablet	1500mg (elemental calcium 600 mg)	Caltrate®, Calci-Tab 600®, Cal-600®

4.4.4. Available intravenous replacement

Form	Electrolyte Content	Availability
Calcium Gluconate	10% (2.2 mmol/10 mL)	Vial available in Pharmacy and after-hours drug cupboard.

4.4.5. Monitoring

- The normal range of serum total calcium concentration corrected for albumin is 2.1 to 2.6 mmol/L. If the albumin concentration is significantly abnormal, serum ionised calcium should be measured directly.
- Hypocalcaemia is often asymptomatic, but patients may present with any of the following clinical manifestations:
  - Neuromuscular: paraesthesia (perioral, palmar, or plantar), muscle cramps, carpopedal spasm, tetany (Chvostek's and Trousseau's sign), laryngospasm, seizures, coma.
  - Cardiopulmonary: prolonged QTc interval, polymorphic ventricular tachycardia (torsades-des-pointes), atrioventricular heart block, hypotension, cardiomyopathy, bronchospasm
  - Neuropsychiatric: fatigue, irritability, anxiety, delirium
- Careful monitoring of serum magnesium and phosphate levels, as well as renal function and albumin, during administration and appropriate adjustment of dosage is essential. It may be necessary to correct coexisting hypomagnesaemia.
- It is the responsibility of the patient's medical team for ordering the appropriate blood test(s) and checking results as clinically indicated. Electrolyte disturbances that are difficult to treat often indicate significant disease or coexisting ion disturbances. Seek expert advice.
  - Intensive Care or Cardiology referral for cardiac monitoring should be considered in the following circumstances: ECG changes (e.g., prolonged QTc interval, verticular arrhythmia) or severe clinical features (e.g., tetany, carpopedal spasm, laryngospasm, bronchospasm, seizures).
  - Endocrinology should be consulted in the following circumstances: patient requiring IV calcium replacement, significant clinical concern or cause of hypocalcaemia is unclear.
- A blood specimen should be drawn and sent for electrolyte, urea, and creatinine (EUC) levels as clinically indicated for each patient who has been administered calcium replacement therapy. During administration of intravenous therapy, measure serum calcium concentration every 3 to 4 hours.
- During administration of intravenous therapy, an ECG should be monitored for evidence of hypercalcaemia, bradycardia, and other arrhythmias.

5. DOCUMENTATION

Document the prescribing, dispensing and administration of electrolyte replacement therapies in accordance with standard medication documentation processes (e.g., eMEDs, eFluids, paper fluid chart, etc).

6. AUDIT

Monitoring and review of incidents associated with electrolyte replacement for potassium, phosphate, magnesium and calcium.

An audit of the safe storage of concentrated potassium ampoules and pre-mixed bags on wards/ clinical areas across SESLHD will be conducted on an annual basis using the Quality Audit Reporting System (QARS) audit tool.

7. REFERENCES

1. NSW Health Policy Directive. NSW Health Policy Directive PD2024_006 - High-Risk Medicines Management.
2. High Risk Medication Alert – Intravenous Potassium Chloride, Australian Commission on Quality and Safety in Healthcare. October 2003.
3. Electrolyte Abnormalities. Australian Therapeutic Guidelines. Published March 2014. Amended June 2019 © Therapeutic Guidelines Ltd (eTG November 2020 edition).
4. MIMS Online. Full Product Information (online). Available at: https://www.mimsonline.com.au/
5. Australian Medicines Handbook 2020 (online). Available at: https://amhonline.amh.net.au/
6. Australian Injectable Drugs Handbook 8th edn (online). Available at: https://aidh.hcn.com.au/
7. Micromedex 2020 (online) Available at: https://www.micromedexsolutions.com/
8. Bailey A. How should intravenous potassium chloride be administered in adults. Medicines Q&A 186.2. Welsh Medicines Information Centre. Cardiff July 2008.
9. Mount, D., 2020. *Clinical Manifestations And Treatment Of Hypokalemia In Adults*. Uptodate. Available at: https://www.uptodate.com/
10. Yu, A. and Stubbs, J., 2020. *Hypophosphatemia: Evaluation And Treatment*. Uptodate. Available at: <https://www.uptodate.com/
11. Joyce Wu and Andrew Carter. Magnesium: the forgotten electrolyte, Australian Prescriber: 2007;30:102-5.
12. Yu, A., 2020. *Hypomagnesemia: Evaluation And Treatment*. Uptodate. Available at: https://www.uptodate.com/
13. Goltzman, D., 2020. *Treatment Of Hypocalcemia*. Uptodate. Available at: https://www.uptodate.com/
14. Queensland Health Medicines Regulation and Quality, Fluid and Electrolyte Guideline Working Party, 2016. *Prescribing HYPO-Electrolyte Disturbances In Adults*. The State of Queensland, p.1.
15. NSW Health Pathology. Venepuncture Procedure. NSWHP_PR_096. April 2024.

8. VERSION AND APPROVAL HISTORY

Date	Version	Version and approval notes
26 April 2024	1	New document to standardise practice across SESLHD, replacing SGHTSH CLIN278, POWH CLIN104, SSEHCLIN085. Approved by SESLHD Drug and Therapeutics Committee and SESLHD Clinical and Quality Council.
26 April 2024	1.1	Formatting change made by SESLHD Policy.
1 July 2024	1.2	Minor amendment. Updates to the storage locations at TSH and including information on ADC safe storage. Approved by SESLHD Drug and Therapeutics Committee.
21 October 2024	1.3	Minor amendment. Updates to products available, venepuncture advice and enhancement to management of hypocalcaemia as per Endocrinology. Approved by SESLHD Drug and Therapeutics Committee.