**Electrolyte disturbances that are difficult to treat often indicate significant disease or coexisting ion disturbances – Seek Advice.**

**Unit-specific protocols for electrolyte disturbances take precedence over these guidelines.**

**Where several treatment options are provided, undertake in a stepwise fashion not concurrently. Sufficient time between interventions should elapse to ensure maximal response has occurred.**

**Rapid administration of electrolytes or correction of severe derangements may result in cardiac arrhythmias - consider cardiac monitoring.**

**Electrolyte solutions are incompatible with blood products, some medications and often each other. Seek advice before mixing together in an infusion or giving simultaneously via the same IV line.**

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### 1. HYPOkalaemia (Mild: 3.1–3.5mmol/L; Moderate: 2.5–3.0mmol/L; Severe: less than 2.5mmol/L)

- Plasma levels below 3.0mmol/L may result in arrhythmias. Consider cardiac monitoring.
- May be due to Total Body Deficit (where a 1mmol/L drop in plasma level represents a total body loss of 200 to 400mmol) or trans-cellular redistribution caused by a range of conditions and drugs (e.g. metabolic acidosis, diabetic ketoacidosis, insulin and salbutamol).
- If repeated, check magnesium and replace if necessary, check for medications which may decrease potassium (e.g. diuretics). Ensure potassium containing fluid is administered as necessary (see IV Fluid Guidelines).

#### Moderate to severe hypokalaemia

- **Treat with both IV and (where possible) oral supplementation.** Patients usually require at least 80–800mmol potassium extra in next 24 hours (i.e. 100–140mmol in total, including normal daily requirements).
- **Repeat plasma levels 4 hours after commencing treatment and review plan.**

#### Symptomatic hypokalaemia

- **All potassium containing infusions must be given via an infusion pump or burette.**
- **Maximum CONCENTRATION peripherally = 40mmol/L to prevent phlebitis.**
- **If maximum concentrations are exceeded; administer through a large vein with high blood flow (e.g. femoral vein) or central venous catheter.**

### 2. HYPOmagnesaemia (Mild: less than 0.9mmol/L; Moderate: less than 0.7mmol/L; Severe: less than 0.4mmol/L)

- Hypomagnesaemia is common in hospitalised patients, especially the severely ill.
- Magnesium may not be included with all electrolyte pathology requests. A specific request may be needed.
- Beware of repeated doses in renal impairment.

#### Severe or symptomatic hypomagnesaemia (e.g. tremors, weakness, swallowing difficulties, cardiac arrhythmias or seizures)

- **Correct with intravenous magnesium sulphate:**
  - » Each 5mL ampoule contains 2.47g magnesium sulphate equivalent to 10mmol magnesium.
  - **Mild hypokalaemia**
  - **Mild or asymptomatic hypokalaemia**
    - Treat with oral supplementation:
      - » Magnesium aspartate tablets 500mg (e.g. Magmira®) 1–2 tablets (1.54–3.08mmol) twice daily. Up to 6 tablets (9.24mmol) daily in divided doses may be required. Diarrhoea is a common side effect.

#### Severe or symptomatic hypomagnesaemia (e.g. drowsiness, headache, seizures)

- **Is a medical emergency. Consider management in an intensive care/high dependency setting. Hypertonic saline and airway access may be indicated.**

#### Symptomatic hypomagnesaemia (e.g. drowsiness, headache, seizures)

- **Assess fluid status:**
  - » If hypovolaemic, correct intravascular deficit with 0.9% sodium chloride (see IV Fluid Guidelines);
  - If euvoalaemic or hypervolaemic, consider potential causes such as medications (SSRI’s, diuretics, antiepileptics), conditions associated with inappropriate ADH secretion or reduced effective circulating volume (cirrhosis, cardiac failure). Manage with fluid restriction.
  - **Repeat plasma levels 6 hours after commencing treatment.**

### 3. HYPOnatraemia (Mild: less than 135mmol/L; Moderate: less than 130mmol/L; Severe: less than 120mmol/L)

- Seek senior advice especially if severe or symptomatic (e.g. drowsiness, headache, seizures).
- Management requires careful assessment of fluid status and biochemical indices.
- Serum sodium concentration should be increased by:
  - » Not more than 0.5mmol/L per hour;
  - » Not more than 10mmol/L in 24 hours to prevent permanent neurological injury.
- The normal mainstay of IV therapy is 0.9% sodium chloride (not hypertonic saline).

#### Severe or symptomatic hyponatraemia (e.g. drowsiness, headache, seizures)

- **Assess with oral supplementation:**
  - » Magnesium aspartate tablets 500mg (e.g. Magmira®) 1–2 tablets (1.54–3.08mmol) twice daily. Up to 6 tablets (9.24mmol) daily in divided doses may be required. Diarrhoea is a common side effect.

#### Symptomatic hyponatraemia (e.g. haemolysis, respiratory failure, cardiac arrhythmias or seizures)

- **Assess with oral supplementation:**
  - » Magnesium aspartate tablets 500mg (e.g. Magmira®) 1–2 tablets (1.54–3.08mmol) twice daily. Up to 6 tablets (9.24mmol) daily in divided doses may be required. Diarrhoea is a common side effect.

#### Symptomatic hyponatraemia (e.g. e.g. haemolysis, respiratory failure, cardiac arrhythmias or seizures)

- **Assess with oral supplementation:**
  - » Magnesium aspartate tablets 500mg (e.g. Magmira®) 1–2 tablets (1.54–3.08mmol) twice daily. Up to 6 tablets (9.24mmol) daily in divided doses may be required. Diarrhoea is a common side effect.

### 4. HYPOphosphataemia (Mild: less than 0.8mmol/L; Moderate: less than 0.5mmol/L; Severe: less than 0.3mmol/L)

- Phosphate does not normally need replacement until less than 0.6mmol/L except if alcoholism/withdrawal, malnutrition, re-feeding syndrome, receiving TPN, renal phosphate wasting, recovery from diabetic ketoacidosis or respiratory failure.
- Sodium dihydrogen phosphate contains 10mmol of phosphate and 10mmol of sodium in a 10mL ampoule. It contains zero potassium.

#### Severe or symptomatic hypophosphataemia (e.g. haemolysis, respiratory failure, cardiac arrhythmias)

- **Correct with intravenous phosphate:**
  - » Each 5mL ampoule contains 2.47g magnesium sulphate equivalent to 10mmol magnesium.
  - **Mild hypophosphataemia**
  - **Mild or asymptomatic hypophosphataemia**
    - Treat with oral supplementation:
      - » Effervescent phosphate tablets 500mg (e.g. Phosphate Sandoz®) 1–2 tablets (16.1–32.2mmol) up to three times a day. Diarrhoea is a common side effect.
      - If not tolerated: one ampoule (10mmol) of sodium dihydrogen phosphate in 250mL of 0.9% sodium chloride infused slowly over 2 to 6 hours into a large vein.

#### Severe or symptomatic hypophosphataemia (e.g. pertoral/finger paraesthesia, seizures, tetany, positive Chvostek’s/Trousseau’s or high risk of becoming symptomatic (e.g. post-parathyroidectomy)

- **Correct with intravenous calcium gluconate:**
  - » Administer two ampoules (4.4mmol) in 100mL 0.9% sodium chloride over 20 minutes.

### 5. HYPOcalcemia (Mild: less than 2.15mmol/L corrected; Moderate: less than 1.9mmol/L corrected; Severe: less than 1.5mmol/L corrected or 0.75mmol/L (IONISED))

#### Moderate to severe hypocalcaemia

- **Treat with oral supplementation:**
  - » Effervescent calcium tablets 1g (Calcisource®) 1–2 tablets (25–50mmol) daily;
  - Calcium carbonate 150mg tablets, equivalent to 600mg of calcium, (Calcitrate®) 1–2 tablets (15–30mmol) daily. Give with food.
• Electrolyte disturbances that are difficult to treat often indicate significant disease or coexisting ion disturbances – Seek Advice.
• Unit-specific protocols for electrolyte disturbances take precedence over these guidelines.
• Where several treatment options are provided, undertake in a stepwise fashion not concurrently. Sufficient time between interventions should elapse to ensure maximal response has occurred.
• Rapid administration of electrolytes or correction of severe derangements may result in cardiac arrhythmias - consider cardiac monitoring.

Electrolyte disturbances

1. HYPERkalaemia (Mild: 5.1–5.9mmol/L, Moderate: 6.0–6.4mmol/L, Severe: more than 6.5mmol/L)

• Consider clinical situation. If asymptomatic confirm level. Consider possibility of sample haemolysis.
• Hyperkalaemia is more sinister in setting of acute rapid rise rather than chronic renal failure and, in patients with pre-existing heart failure.
• Severe or symptomatic (e.g. muscular weakness and/or ECG changes [e.g. peaked T waves])
  » Institute continuous ECG monitoring.
  » Seek senior advice. Consider:
    a. Protecting heart:
      i. If ECG abnormalities are present - calcium gluconate one ampoule (2.2mmol of calcium) IV via a central vein or slowly over 2–3 minutes into a large vein. If ECG does not normalise within 10 minutes, dose may be repeated (to a total of 0.1mmol/kg).
    b. Reducing serum potassium levels:
      i. Intravenous glucose and insulin - glucose 50% 50mL with 10 units short-acting insulin IV over 5 minutes. Monitor blood glucose levels hourly; and/OR
      ii. Nebulised salbutamol 10 mg (2 of the 5mg/2.5mL nebules); and/OR
      iii. If metabolic acidosis present, sodium bicarbonate 8.4% 50mL IV over 5–15 minutes.
• Removing potassium from the body:
  » Resuming potassium from the body:
    a. Resonium-A® - give 15–30g orally up to four times daily or 60g as a retention enema daily; and/OR
    b. Dialysis - urgent dialysis may be required.
  » Reviewing medication:
    a. Withhold any potassium retaining drugs (ACE inhibitors, angiotensin receptor antagonists, potassium sparing diuretics) or potassium supplements.
    b. Monitor potassium level hourly.

Mild to moderate or asymptomatic
• Place on a low potassium diet.
• Withhold potassium-containing drugs (e.g. Span-K®) and if possible, drugs that may cause or aggravate hyperkalaemia (e.g. spironolactone, trimethoprim, β-blockers, NSAIDs, ACE inhibitors, angiotensin receptor antagonists, digoxin).
• Monitor potassium levels every 12 hours.

Long term management
• Review for possible reversible causes of hyperkalaemia (e.g. haemolysis, acidosis, renal impairment).

2. HYPERcalcaemia (Mild: 3.5–4.0mmol/L, Moderate: 3.0–3.2mmol/L, Severe more than 3.2mmol/L – corrected)

• Hypercalcaemia is most commonly due to primary hyperparathyroidism OR hypercalcaemia associated with malignancy.
• Severe or symptomatic (e.g. lethargy, coma, ECG changes [shortened QT interval])
  » Rehydration - intravenous sodium chloride 0.9%. Volume infused should be sufficient to maintain a large urine output (e.g. 60mL/hr). Seek senior advice.
  » Bisphosphonate therapy - see local guidelines or if not available, consider intravenous disodium pamidronate.
  » Corrected Calcium (mmol/L) | Total Pamidronate Dose (mg)
  | 3.0–3.5 | 30–60
  | 3.5–4.0 | 90
  | More than 4.0 | 90; and consider dialysis

•Administer as infusion in 250mL sodium chloride 0.9% or glucose 5%.
• Infusion over 30 to 90 minutes at a rate not exceeding 1mg/minute.

N.B. Renal impairment: Pamidronate is not recommended in patients with CrCl less than 30mL/min. Seek expert advice. In less severe renal impairment, reduce the infusion rate to 20mg/hr.

Long term management
• Review for possible causes including diet/supplements (vitamin D or calcium); sarcoidosis and other granulomatous disease; drug causes such as calcitriol (Rocaltril®) excess or thiazide diuretics; and hypercalcaemia due to spinal cord injury and/or immobility.

3. HYPERnatraemia (Mild to Moderate: 145–159mmol/L, Severe: more than 160mmol/L)

• Seek senior advice especially if severe or symptomatic.
• Often due to fluid deficit - refer to IV Fluid Guideline.
• Oral fluid replacement, with water, is safest.
• Severe or symptomatic (e.g. hyperthermia, delirium, seizures, coma)
  » A medical emergency. Consider management in an intensive care/high dependency setting.
  » Serum sodium concentration should be reduced by:
    a. Not more than 0.5mmol/L per hour;
    b. Not more than 10mmol/L in 24 hours to prevent permanent neurological injury.
    c. Intravenous fluids without added sodium (generally glucose 5%) may be needed.
    d. Monitor every 4 hours in the first 24 hours.

4. HYPERmagnesaemia (Severe: 2.5mmol/L)

• May be deliberate in pregnancy. Magnesium is used to treat/ prevent eclampsia/severe pre-eclampsia. Always contact Obstetrician.
• Severe or symptomatic (e.g. loss of deep tendon reflexes, respiratory depression, paralysis, reduced consciousness)
  » Intravenous calcium gluconate provides immediate but transient antagonism of toxic effects.
  » One ampoule (2.2mmol) of calcium gluconate in 0.9% sodium chloride should be administered over 5 minutes. Repeat if necessary.
• Kidney excretion should be promoted with intravenous sodium chloride 0.9%, aiming for a urine output of at least 50 mL per hour.
• If this urine output can’t be achieved, intravenous frusemide can be added.
• Dialysis may be needed.
• Review diet/medication use for antacids, enemas, supplements and lithium.