Safe prescribing of intravenous Potassium and other Electrolytes

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Fatal or serious incidents related to IV Potassium

1. Potassium chloride ampoule selected instead of Sodium chloride 0.9% 10mL to flush cannula → patient died

2. Potassium chloride ampoule selected instead of WFI to reconstitute a medication for IV admin – near miss

- Error of substitution
- System remedy – removed Potassium concentrated amps from general wards & only allow pre-mixed infusion bags.
- Store Potassium amps away from other look alike amps (e.g. N/S, WFI)
3. Potassium chloride 10mL given as a bolus $\rightarrow$ patient died
   - Never write “stat” or “bolus” for an IV potassium order
   - Always specify the diluent type, volume, and infusion rate in mL/hr

4. Potassium chloride added to a running fluid infusion $\rightarrow$ cardiac arrest
   - Do NOT add potassium into a running infusion.
   - Use premixed bags
   - If potassium needs to be added into a new IV fluid bag, invert the bag multiple time to ensure the solution is thoroughly mixed.
5. Several litres of IV fluids containing KCl given to a patient requiring fluid resus \(\rightarrow\) hyperkalaemia, patient fatality

- Avoid bolusing IV fluids that contains potassium
- Hartmann’s & PlasmaLyte 148 replacement contains potassium 5mmol/L

6. Inadvertent infusion of KCl via an epidural catheter (KCl mistaken for N/S to dilute anaesthetic)

7. Other cases

- KCL 40mmol IV bolus given instead of Frusemide 40mg \(\rightarrow\text{death}\)
- Potassium phosphate injection used instead of heparin to flush a central line \(\rightarrow\text{death}\)
- 10month old girl post ASD surgery, died due to hyperK, source of exogenous K unknown
- Incorrect preparation of potassium solution by pharmacy infused into a 6month old infant \(\rightarrow\text{death}\)
- Concentrated KCL syringe given to mother of a child dependent on home TPN. KCL was meant to be injected into the TPN bag before infusion. But mother injected the KCl directly into the central line, child died.
IV Potassium prescribing

Maximum concentration:
via a peripheral line = \(30\text{mmol/L}\)

Maximum Infusion rate:
with no cardiac monitoring = \(10\text{mmol/hour}\)
**Potassium Products available:**

**Intravenous**

**Pre-mixed bags for peripheral line:**
- Potassium chloride **30mmol** in Sodium chloride 0.9% 1L
- Potassium chloride **30mmol** in Glucose 4% + Sodium chloride 0.18% 1L
- Potassium chloride **30mmol** in Glucose 5% 1L
- Potassium chloride **10mmol** in Sodium Chloride **0.29% 100mL** (isotonic)
  - This bags is better tolerated (less pain) when infused over 2 hours (ie 50mL/hr)

**Oral**
- Potassium chloride SR = 8mmol per tablet
- Chlorvescent ® = 14mmol per tablet
- Large doses → N/V
Potassium replacement requirements

Mrs RL
39yo F, 70kg
Acute exacerbation of Ulcerative Colitis
Diarrhoea 10-15x/day, NBM/CF, IV fluids (no electrolytes added)

Day 9 of admission: Potassium level 2.4 mmol/L

Prescribe potassium replacement
Potassium deficit

- Total body K content of a 70kg person = 4000mmol
- Intra cellular concentration: 140mmol/L
- Extra cellular concentration: 3 – 5mmol/L (2% of total body K)

In the absence of factors affecting IC:EC ratio of potassium, total body deficit of potassium is approx 100mmol for every 0.5mmol/L reduction in serum potassium below [K] 4.2mmol/L.

- Serum [K] 3mmol/L = total body deficit approx 230mmol
- Serum [K] 2.5mmol/L = total body deficit approx 330mmol

- Replace deficit over a few days
- Check time of infusion w.r.t blood test
**Factors that cause hypokalaemia:**

1. **Apparent deficit** – intracellular shifting of potassium:
   Metabolic alkalosis, beta2-adrenergic agonists (Salbutamol), Insulin
   
   - **Alkalosis:** $H^+ \leftrightarrow K^+$
   - **Acidosis:** $H^+ \rightarrow K^+$
   
   (Correction of acidosis $\rightarrow$ decrease $[K]$)

2. **Abnormal losses** - diarrhea, high fistula/stoma outputs, medications

3. **Inadequate supplementation** (NBM & no routine IV replacement)
   - Daily requirement of potassium: $1 – 2 \text{mmol/kg/day}$
Safe Handling of Intravenous Potassium Chloride and Other Concentrated Potassium Salts (Adult) -

Key points for safe prescribing:

- **Oral** potassium is safer than IV
- Prescribe pre-mixed bags
- Clearly specify dose (in mmol), diluent type and volume, infusion rate
- Maximum infusion rate **10mmol/hour**
- Maximum concentration via peripheral line 30 mmol/L
  - *(except for the KCl 10mmol in NaCl 0.29% 100mL isotonic bag)*
- Never write “stat” or “bolus” for an IV potassium order
Magnesium

- **General requirements:** 10 – 20 mmol/day
- **Intravenous products:**
  - Magnesium Sulfate 10 mmol/5mL
- **Concentration:** 10 mmol /100mL
- **Infusion rate:** 10 mmol / hour
  - NOT compatible with bicarbonate, calcium, phosphate salts

**Oral:** Magnesium aspartate 500mg = Mg 1.6 mmol
Calcium

Intravenous preparations:
- **Calcium gluconate** 2.2mmol/10mL
  - 10% = 1g/10mL
- **Calcium chloride** 6.8mmol/10mL
  - 10% = 1g/10mL

**Concentration:** 2.2mmol /100mL

**Infusion rate:** 2.2mmol / hour

**Compatibility:**
- **Compatible** with Sodium chloride 0.9%, Glucose 5%, Hartmann’s
- **NOT compatible** with fat emulsions, blood products, IV fluids containing phosphates, magnesium sulfate, bicarbonate, citrate salts.
Phosphate Administration in Adults
(WSLHD policy online)

- **General requirements:** 20 - 40 mmol / day
- **Intravenous products:**
  - Potassium dihydrogen phosphate 10mmol / 10mL
  - Sodium dihydrogen phosphate 10mmol / 10mL
- **Concentration:** max 40mmol/L
- **Infusion rate:** max 10mmol / hour

Compatibility:
- **NOT compatible** with IV fluids containing calcium and magnesium (e.g. Hartmann’s, Plasmalyte-148 replacement)
General considerations for electrolyte replacement

- Cause of depletion (input vs losses)
- Severity of depletion (may take several days to replenish body deficits)
- Size of patient
- Renal function
- Medications
- Oral vs intravenous (peripheral vs central line)
- Fast infusion / large doses → more side effects
  - Exceed renal threshold → increase % of dose excreted in the urine.
### Examples of IV electrolyte orders

<table>
<thead>
<tr>
<th>Date</th>
<th>Indication</th>
<th>Fluid Type</th>
<th>Volume (mL)</th>
<th>Additive and Amount</th>
<th>Rate (mL/hr)</th>
<th>Route</th>
<th>Prescriber's Name Print &amp; Signature/pager No.</th>
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</thead>
<tbody>
<tr>
<td>1/2/19</td>
<td>Maintenance</td>
<td>Glucose 4% + Sodium Chloride 0.18%</td>
<td>1000 mL</td>
<td>Potassium Chloride 30 mmol</td>
<td>80</td>
<td>IV</td>
<td>Dr Anne Jones</td>
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<td>A Jones 12345</td>
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<tr>
<td>1/2/19</td>
<td>Hypokalaemia</td>
<td>Sodium Chloride 0.29%</td>
<td>100 mL</td>
<td>Potassium Chloride 10 mmol</td>
<td>100</td>
<td>IV</td>
<td>Dr Anne Jones</td>
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<tr>
<td>1/2/19</td>
<td>Hypophosphatemia</td>
<td>Sodium Chloride 0.9%</td>
<td>1000 mL</td>
<td>Potassium Dihydrogen Phosphate 30 mmol</td>
<td>60</td>
<td>IV</td>
<td>Dr Anne Jones</td>
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<td>A Jones 12345</td>
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<tr>
<td>2/2/19</td>
<td>Hypomagnesemia</td>
<td>Sodium Chloride 0.9%</td>
<td>100 mL</td>
<td>Magnesium sulfate 10mmol</td>
<td>50</td>
<td>IV</td>
<td>Dr Anne Jones</td>
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<tr>
<td>2/2/19</td>
<td>Hypocalcaemia</td>
<td>Sodium Chloride 0.9%</td>
<td>100 mL</td>
<td>Calcium Gluconate 2.2mmol</td>
<td>100</td>
<td>IV</td>
<td>Dr Anne Jones</td>
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