Introduction

This hospital wide guideline was developed to achieve the following:
- Allow the removal of highly concentrated potassium preparations from all patient care units including PICU, NICU, Unit 1 and OR
- Allow the discontinuation of the use of Buretrols for administration of intravenous fluid and TPN therapy, hence reducing opportunity for dosing error and infection risk created by ‘adding to the buretrol’
- Provide a method for delivering extra potassium as a prescribed dose independent of the maintenance IV infusion rate in cases of critically low potassium.
- Provide a method of delivering an intermittent potassium infusion where the dose is visible on the syringe pump screen in mmol with safe dosing and rate limits set.
- Utilize commercially available IV solutions containing potassium chloride when possible to reduce pharmacy workload and potential error required to make up special IV fluid bags

Potassium is the major positive ion in intracellular fluid and is essential for maintenance of:
- Electropotential gradient of the cell membrane
- Isotonicity
- Acid-base balance

The kidney has a major role in potassium homeostasis. Serum potassium does not accurately reflect total body stores

The reference range (from SCM and CLS) for serum potassium is:
- 1 day – 3 months: 4.0 – 6.2 mmol/L
- 4 months – 11 months: 3.7 – 5.6 mmol/L
- Older than 1 year: 3.3 – 5.1 mmol/L

Definitions of pediatric/neonatal hypokalemia:
- Mild: 3.0-3.5 mmol/L
- Moderate: 2.0-2.9 mmol/L
- Severe: ≤ 1.9 mmol/L

Capillary samples demonstrating hyperkalemia must be confirmed by a venous or arterial sample, as haemolysis caused by the collection technique may falsely elevate the level.
Section 1: Hypokalemia

CLINICAL SIGNS OF POTASSIUM DEFICIT

Signs and symptoms of potassium deficit are late and non-specific including:
- Apathy
- Weakness
- Cramping
- Paraesthesia
- Heart rhythm disturbance (uncommon in children with healthy hearts)
- ECG classically shows sagging ST segments, depression of T waves and elevated U waves. QTc can be prolonged.
- Muscle paralysis (late sign)

There is evidence, at least in adults, that potassium levels of less than 3.5 mmol/L predispose patients to peri-operative arrhythmias\(^1\). Also hypokalemia has contributed to fatal arrhythmias in children with DKA and potassium losing tubulopathies (chronic hypokalemia of < 2.5 and acute hypokalemia of < 2.0 mmol/L)\(^2\).

NORMAL POTASSIUM INFUSION RATES AND REQUIREMENTS

Approximate potassium replacement in children receiving intravenous fluids

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Fluid requirements (mL/day)</th>
<th>20 mmol/L KCl Potassium intake * (mmol/kg/day)</th>
<th>Rate of potassium (mmol/kg/hr)</th>
<th>40 mmol/L KCl Potassium intake ** (mmol/kg/day)</th>
<th>Rate of potassium (mmol/kg/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>300</td>
<td>2</td>
<td>0.08</td>
<td>4</td>
<td>0.17</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
<td>2</td>
<td>0.08</td>
<td>4</td>
<td>0.17</td>
</tr>
<tr>
<td>10</td>
<td>1000</td>
<td>2</td>
<td>0.08</td>
<td>4</td>
<td>0.17</td>
</tr>
<tr>
<td>20</td>
<td>1500</td>
<td>1.5</td>
<td>0.06</td>
<td>3</td>
<td>0.13</td>
</tr>
<tr>
<td>30</td>
<td>1750</td>
<td>1.2</td>
<td>0.05</td>
<td>2.3</td>
<td>0.1</td>
</tr>
<tr>
<td>40</td>
<td>2000</td>
<td>1</td>
<td>0.04</td>
<td>2</td>
<td>0.08</td>
</tr>
<tr>
<td>50</td>
<td>2160</td>
<td>0.9</td>
<td>0.04</td>
<td>1.7</td>
<td>0.07</td>
</tr>
<tr>
<td>70</td>
<td>3000</td>
<td>0.9</td>
<td>0.04</td>
<td>1.7</td>
<td>0.07</td>
</tr>
</tbody>
</table>

* Equates to normal daily maintenance requirements for potassium
** Equates to twice normal requirement

Calculation of total daily potassium intake (mmol/kg/day) = \( \frac{\text{mL/day} \times \text{KCl concentration/L}}{\text{weight(kg)} \times 1000} \)

PATIENTS ON TPN

- Ensure adequate potassium is prescribed in daily TPN by ordering the required mmol/kg/day in the daily volume delivered, rather than solely the KCl concentration in mmol/L of TPN.
- When reordering TPN the following day recalculate the potassium required in the TPN, rather than continue or repeat the more concentrated potassium intermittent infusion.
CONSIDERATIONS FOR PARENTERAL POTASSIUM ADMINISTRATION

- Include ALL sources of potassium intake (eg. oral, maintenance IV, TPN and intermittent infusions) when calculating the total daily intake in mmol/kg/day
- Potassium salts MUST NEVER be given IM.
- Rapid intravenous administration of potassium by any route is NEVER recommended. This can cause death.
- All patients must have an accurate weight recorded.
- Up to 60 mmol/L via peripheral IV is acceptable with careful checking of the IV site during infusion as solutions > 40 mmol/L can cause serious extravasation burns.
- If administered peripherally, the patency of the line must be ensured. If patency of the IV is at all in question, a new IV must be inserted.
- A total potassium concentration at the Y-site ≤ 60 mmol/L is approximated when a potassium free maintenance fluid running at normal maintenance fluid rates has an intermittent infusion of:
  o 20 mmol KCl/100 mL solution infusing via syringe pump at
  o 0.25 mmol/kg/hr (1 mmol/kg = 5 mL/kg) over 4 hrs
  o max 20 mmol in 4 hrs
  o (see chart below).

WITH *POTASSIUM FREE* MAINTENANCE INFUSION

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Maintenance infusion (<em>potassium free</em>) (Rate = mL/hr)</th>
<th>Intermittent infusion of 20 mmol/100mL KCl at 0.25 mmol/kg/hr (1 mmol/kg = 5 mL/kg) over 4hrs to a maximum of 20 mmol or 100mL (Rate = mL/hr)</th>
<th>Resulting concentration of potassium at Y site (mmol/L)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>20</td>
<td>6.25</td>
<td>48</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>12.5</td>
<td>48</td>
</tr>
<tr>
<td>20</td>
<td>60</td>
<td>25</td>
<td>59</td>
</tr>
<tr>
<td>50</td>
<td>90</td>
<td>25</td>
<td>43</td>
</tr>
</tbody>
</table>

*Maximum peripheral concentration = 60 mmol/L

WITH 20 mmol/L KCl TPN or MAINTENANCE INFUSION

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Maintenance infusion (20 mmol/L KCl) (Rate = mL/hr)</th>
<th>Intermittent infusion of 20 mmol/100mL KCl at 0.25 mmol/kg/hr (1 mmol/kg = 5 mL/kg) over 4hrs to a maximum of 20 mmol or 100mL (Rate = mL/hr)</th>
<th>Resulting concentration of potassium at Y site (mmol/L)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>20</td>
<td>6.25</td>
<td>63</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>12.5</td>
<td>63</td>
</tr>
<tr>
<td>20</td>
<td>60</td>
<td>25</td>
<td>73</td>
</tr>
<tr>
<td>50</td>
<td>90</td>
<td>25</td>
<td>59</td>
</tr>
</tbody>
</table>

*Maximum peripheral concentration = 60 mmol/L
**WITH 40 mmol/L KCl TPN or MAINTENANCE INFUSION**

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Maintenance infusion (40 mmol/L KCl) (Rate = mL/hr)</th>
<th>Intermittent infusion of 20 mmol/100mL KCl at 0.25 mmol/kg/hr (1 mmol/kg = 5 mL/kg) over 4hrs to a maximum of 20mmol or 100mL (Rate = mL/hr)</th>
<th>Resulting concentration of potassium at Y site (mmol/L)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>20</td>
<td>6.25</td>
<td>78</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>12.5</td>
<td>78</td>
</tr>
<tr>
<td>20</td>
<td>60</td>
<td>25</td>
<td>87</td>
</tr>
<tr>
<td>50</td>
<td>90</td>
<td>25</td>
<td>75</td>
</tr>
</tbody>
</table>

*Maximum peripheral concentration = 60 mmol/L

Equation to calculate Total Potassium Concentration at Y site (mmol/L):

1) Calculate the total amount of KCl infusing per hour (mmol/hr) =
   \[\text{Concentration of KCl in Maintenance fluid (mmol/mL)} \times \text{Maintenance fluid rate (mL/hr)}\]
   \[+\]
   \[\text{Concentration of KCl in intermittent infusion (mmol/mL)} \times \text{Intermittent infusion rate (mL/hr)}\]

2) Divide result by the total hourly fluid rate (mL/hr) =
   \[\text{Maintenance fluid rate (mL/hr)} + \text{Intermittent fluid rate (mL/hr)}\]

3) Multiply by 1000 for mmol/L.

From the above tables it can be seen that for peripheral intravenous access, a potassium free maintenance solution allows for the safest administration of 20 mmol/100mL KCl Y-ed into the maintenance line.

If multiple infusions containing potassium are running, the potassium calculator can be used to check the resultant Y-site concentration. [Potassium calculator](#)

**MEDFUSION SYRINGE PUMP LIMITS**

Medfusion syringe pump soft and hard limits will be set based upon the monitoring required for the patient.

**DOSE AND RATE LIMITS (intermittent infusions)**

- PICU/ED and OR drug libraries WITH cardiac monitoring. Intermittent potassium infusion usually over 1-2 hours (range between 1 – 4 hours, max rate 1 mmol/kg/hr up to a max rate of 40 mmol/hr). Provides a maximum dose of 1 mmol/kg up to a max dose of 40 mmol.
  - Hard limits (0.02 and 1 mmol/kg per dose)
  - Soft limits (0.1 and 1 mmol/kg per dose)

- General pediatrics drug library WITH or WITHOUT cardiac monitoring. Intermittent potassium infusion over 2-4 hours (max rate infusion 0.5 mmol/kg/hr up to max rate of 10 mmol/hr). Provides a maximum dose of 1 mmol/kg up to max dose of 20 mmol.
NEONATAL AND PEDIATRIC POTASSIUM ADMINISTRATION GUIDELINES

Hard limits (0.02 and 1 mmol/kg per dose)
Soft limits (0.1 and 1 mmol/kg per dose)

RATE LIMITS (continuous infusions)

- General pediatrics and PICU/ED drug library for continuous infusion. Must FIRST confirm total potassium from all sources to determine if cardiac monitoring is required.
- All areas max rate 0.25 mmol/kg/hr (up to a maximum rate of 10 mmol/hr).
  Hard limits (0.01 and 0.25 mmol/kg/hr)
  Soft limits (0.05 and 0.25 mmol/kg/hr)

NURSING CONSIDERATIONS (See Nursing Policy and Procedure M-1.1)

- An independent double check and signature by a second RN, LPN, physician or pharmacist is required for initiating and/or changing rates of all potassium chloride infusions
- Ensure that appropriate IV site (central or peripheral) and monitoring is available.
- Recommended maximum Y-site concentration limits:

<table>
<thead>
<tr>
<th></th>
<th>General Pediatrics</th>
<th>PICU/ Unit 1/ OR</th>
<th>NICU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral- Combined Y-site conc</td>
<td>60 mmol/L</td>
<td>60 mmol/L</td>
<td>60 mmol/L</td>
</tr>
<tr>
<td>Central- Maintenance/TPN</td>
<td>80 mmol/L</td>
<td>120 mmol/L</td>
<td>80 mmol/L</td>
</tr>
<tr>
<td>Central- Intermittent Infusion</td>
<td>20 mmol/100 mL</td>
<td>20 mmol/100 mL</td>
<td>N/A</td>
</tr>
<tr>
<td>Central- Combined Y-site conc</td>
<td>120 mmol/L</td>
<td>200 mmol/L</td>
<td>N/A</td>
</tr>
</tbody>
</table>

† Note that 20 mmol/100 mL = 200 mmol/L

- For all peripheral infusions of potassium, the intravenous site must be inspected every hour and the infusion ceased immediately if there is any evidence of phlebitis (redness at the site or along the path of the vein) or extravasation.
- The potassium infusion should be immediately stopped if extravasation is suspected.
- Refer to Extravasation Policy and Procedure and parenteral monograph for further details.
- Do not add extra potassium to premixed potassium bags.

MEDICAL CONSIDERATIONS

- Hypokalemia may be corrected either orally and/or parenterally.
- Acid base balance has a profound effect in serum potassium.
  - In alkalosis total body potassium will be less depleted than depicted by the serum potassium, due to intracellular shift of potassium.
  - In acidosis total body potassium will be more depleted than is depicted by the serum potassium, due to extracellular shift of potassium.
- Extreme caution must be exercised when administering potassium to children with impaired renal function or renal failure.
- Children with diabetic ketoacidosis can have up to 60 mmol/L of potassium in a standard IV fluid bag. Refer to the ACH DKA Guideline. DKA Guideline
- The Neonatal Intensive Care Units have a separate guideline that is included in this document. These Units may administer up to 80 mmol/L of potassium in standard IV fluid bags.
• Premixed 1 liter IV bags containing 20 mmol/L and 40 mmol/L of potassium are available for continuous (maintenance) infusions.
• The intermittent infusion premixed 100mL minibags containing potassium chloride 20 mmol/100mL are available on Unit 1, PICU, the night cupboard at ACH, and OR. This product will be administered by syringe pump only.
• Only pharmacy will stock 2 mmol/mL concentrated potassium solution.
• See list of products available on page 10.
• Hypomagnesaemia, hypophosphatemia and hypocalcemia may all be associated with hypokalemia, and may require correction.
• Medical residents must consult the attending physician when indicated on the Flow Chart (pages 8 and 9).
• Recommended maximum Y-site concentration limits:

<table>
<thead>
<tr>
<th></th>
<th>General Pediatrics</th>
<th>PICU/ Unit 1/ OR</th>
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</tr>
<tr>
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<td>80 mmol/L</td>
<td>120 mmol/L</td>
<td>80 mmol/L</td>
</tr>
<tr>
<td>Central- Intermittent Infusion</td>
<td>20 mmol/ 100 mL</td>
<td>20 mmol/ 100 mL</td>
<td>N/A</td>
</tr>
<tr>
<td>Central- Combined Y-site conc</td>
<td>120 mmol/ L</td>
<td>200 mmol/ L†</td>
<td>N/A</td>
</tr>
</tbody>
</table>

† Note that 20 mmol/100 mL = 200 mmol/L

PHARMACY CONSIDERATIONS

• Screening of all potassium orders (oral, TPN, maintenance IV, intermittent infusions, continuous infusions) will confirm calculations of total rate (mmol/kg/hr and mmol/hr), resulting concentration (mmol/L at Y-site), and type of line used for administration (i.e. central vs peripheral). potassium calculator
• Clinical pharmacist will help team to monitor and adjust potassium dose based upon lab work.

MAXIMUM RATE AND DOSE OF POTASSIUM ON WARDS

Consider all sources of potassium intake (eg. oral, maintenance IV, TPN and intermittent infusion). potassium calculator

It is recommended that the total potassium administration rate not normally exceed 0.25 mmol/kg/hr continuously.

Rates up to 0.5 mmol/kg/hr can be administered for an intermittent infusion, but consider cardiac monitoring for rates between 0.25 and 0.5 mmol/kg/hr. The maximum intermittent infusion dose is 20 mmol.

Rates of IV potassium above 0.5 mmol/kg/hr or above 10 mmol/hr, or an intermittent infusion dose higher than 20 mmol REQUIRE the use of a cardiac monitor and PICU admission.

Oral potassium should be held on patients receiving a continuous or intermittent potassium infusion. Restart oral potassium only after a post infusion potassium concentration has been measured and is satisfactory.³
MAXIMUM RATE AND DOSE OF POTASSIUM IN PICU

Consider all sources of potassium intake (eg. oral, maintenance IV, TPN and intermittent infusion). [potassium calculator]

Rates of IV potassium up to 1 mmol/kg/hr to a maximum rate of 40 mmol/hr may be administered in PICU with cardiac monitoring. The maximum intermittent infusion dose is 40 mmol.

Oral potassium should be held on patients receiving a continuous or intermittent potassium infusion. Restart oral potassium only after a post infusion potassium concentration has been measured and is satisfactory (see reference 3).

SUMMARY OF RECOMMENDED MAXIMUM RATES* AND DOSES

<table>
<thead>
<tr>
<th>Continuous Infusion</th>
<th>Intermittent Infusion- Wards/ED</th>
<th>Intermittent Infusion- PICU/ OR</th>
<th>NICU</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 mmol/kg/hr</td>
<td>0.5 mmol/kg/hr</td>
<td>1 mmol/L/kg/hr</td>
<td>See NICU Section</td>
</tr>
<tr>
<td>up to max of 10 mmol/hr</td>
<td>up to max of 10 mmol/hr (consider cardiac monitoring between 0.25-0.5 mmol/kg/hr)</td>
<td>up to max of 40 mmol/hr (with cardiac monitoring)</td>
<td></td>
</tr>
<tr>
<td>Maximum total dose 20 mmol</td>
<td>Maximum total dose 40 mmol</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note these rates include all sources of IV potassium.
**Pediatric Guideline for Potassium Replacement**

Reminder to consider all sources of potassium intake (eg. oral, Maintenance IV, TPN and intermittent infusions)

### Mild Hypokalemia
Serum K = 3-3.5 mmol/L

- **Is the child already receiving maintenance potassium at correct rate?**
  - **NO**
    - Give intravenous OR oral replacement
      - **IV:** Dextrose 5% + 0.45% (or 0.9%) NaCl + 20 mmol/L KCl at maintenance rates* Provides 1-2 mmol/kg/day
        - **ORAL:** 2 mmol/kg/day < 30 kg, 1 mmol/kg/day > 30 kg (divided BID or QID, MAX 20 mmol/dose) of oral KCl
      - Measure serum potassium at least daily
  - **YES**
    - Can the child tolerate oral therapy?
      - **YES**
        - Measure K+ twice daily
      - **NO**
        - Discuss with Attending

### Moderate Hypokalemia
Serum K = 2-2.9 mmol/L

- Notify Attending**; consider ECG when serum K ≤ 2.5 mmol/L

- **Can the child tolerate oral therapy?**
  - **YES**
    - Measure K+ twice daily
  - **NO**
    - Infuse 1 mmol/kg (5 mL/kg) of 20 mmol KCl in 100 mL over 2-4 hours Max rate 0.5 mmol/kg/hr. Max dose of 20 mmol. Y into potassium free maintenance fluids IV line

### Severe Hypokalemia
Serum K ≤ 1.9 mmol/L or abnormal ECG

- **Cardiac monitoring required**

- **Discuss with Attending:** Remove all other sources of KCl, including oral*
  - If TPN running, adjust below regime

- **Infuse 1 mmol/kg (5 mL/kg)** of 20 mmol KCl in **100 mL** over 2-4 hours Max rate 0.5 mmol/kg/hr. Max dose of 20 mmol. Y into potassium free maintenance fluids IV line

- **Measure K+ Q2H. If K+ is increasing but < 2.5 mmol/L continue at same rate. When K+ is > 2.5 mmol/L, discuss with Attending regarding ongoing K+ requirements**

### PICU

- **Measure K+ twice daily**

- **IV:** Dextrose 5% + 0.45% (or 0.9%) NaCl + 20 mmol/L KCl at maintenance rates* Provides 1-2 mmol/kg/day PLUS
  - **ORAL:** 2 mmol/kg/day < 30 kg, 1 mmol/kg/day > 30 kg (divided BID or QID, MAX 20 mmol/dose) of oral KCl

- **K+ level not increased after 4 hours?**
  - **Discuss with Attending**
    - **NO**
      - Infuse K+ Q2H. If K+ is increasing but < 2.5 mmol/L continue at same rate. When K+ is > 2.5 mmol/L, discuss with Attending regarding ongoing K+ requirements**
    - **YES**
      - Measure K+ twice daily

- **K+ level increased after 4 hours?**
  - **Discuss with Attending**
    - **NO**
      - Infuse K+ Q2H. If K+ is increasing but < 2.5 mmol/L continue at same rate. When K+ is > 2.5 mmol/L, discuss with Attending regarding ongoing K+ requirements**
    - **YES**
      - Measure K+ twice daily

- **IN PICU ONLY with cardiac monitoring**
  - Infuse 1 mmol/kg (5 mL/kg) of 20 mmol KCl in **100 mL** over 1-2 hours via a central line Max rate 1 mmol/kg/hr. Max dose 40 mmol. Measure K+ hourly.

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*Full maintenance IV fluid rates are not always appropriate for sick children, especially if < 0.9% NaCl is used. Discuss with the Attending if there is any concern regarding the correct rate of IV fluid administration. If this rate is deemed to be less than or more than traditional full maintenance rates, then the above guideline may require modification.

**With moderate hypokalemia, the clinical circumstances and rate of drop must be considered when deciding the route and rate of potassium replacement; higher amounts of potassium via IV may be indicated.*
**Moderate Hypokalemia**
Serum K = 2.2-2.9 mmol/L

Can the neonate tolerate oral therapy?

NO

Discuss with Attending

K+ level increased after 4 hours?

IV: Dextrose 10% + 0.2% NaCl + 20-40 mmol/L KCl at maintenance rates (Provides 2-6 mmol/kg/day at 100-150 mL/kg/day of fluid at a rate of 0.1-0.25 mmol/kg/hr potassium)

ORAL:
2-4 mmol/kg/day (divided q 2-4h) of oral KCl

Total: 4-10 mmol/kg/day

YES

Measure K+ twice daily

Measure K+ not increased after 4 hours?

Discuss with Attending

K+ level increased after 4 hours?

IV: Dextrose 10% + 0.2% + 40-60 mmol KCl at maintenance rates (Provides 4-9 mmol/kg/day at 100-150 mL/kg/day of fluid at a rate of 0.17-0.38 mmol/kg/hr potassium)

Consider measuring K+ hourly

**Severe Hypokalemia**
Serum K ≤ 1.9 mmol/L
Cardiac monitoring required

IV: Dextrose 10% + 0.2% NaCl + 60 mmol/L KCl at maintenance rates (Provides 6-9 mmol/kg/day at 100-150 mL/kg/day of fluid at a rate of 0.25-0.38 mmol/kg/hr potassium)

Measure K+ Q2H. If K+ is increasing but < 2.5 mmol/L continue at same rate. When K+ is > 2.5 mmol/L, discuss with Attending regarding ongoing K+ requirements
ONGOING POTASSIUM REQUIREMENTS

Ongoing requirements for potassium depend on whether there are ongoing losses or not and whether there is total body potassium depletion or not.

If no, then revert to normal maintenance potassium requirements following the intermittent potassium infusion.

If yes, continue with an appropriate continuous infusion of the 20 mmol/100 mL of KCl infusion based on a calculation of the patients ongoing potassium requirements BUT considering the amounts delivered from all sources e.g. TPN, maintenance fluids, and the continuous KCl infusion. The potassium calculator will be very helpful in this setting. potassium calculator

Remember that continuing to deliver the infusion at 0.25 mmol/kg/hr will administer 6 mmol/kg of KCl over 24 hrs, which may be excessive.

ORAL PREPARATIONS AVAILABLE:

<table>
<thead>
<tr>
<th>Oral Potassium Preparations</th>
<th>Amount of potassium contained in each unit dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium Chloride 600mg (Apo K SR tablet, Micro K CR capsule)</td>
<td>8 mmol K⁺ per tablet</td>
</tr>
<tr>
<td>Potassium Chloride 1500 mg (K Dur SR tablet)</td>
<td>20 mmol K⁺ per tablet</td>
</tr>
<tr>
<td>Potassium Chloride Oral Solution (K- 10)</td>
<td>1.33 mmol/mL</td>
</tr>
</tbody>
</table>
### Intravenous Potassium Containing Preparations Available:

#### Children

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Description</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance infusions:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pediatrics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5W + 0.45% sodium chloride + 20 mmol KCl/L</td>
<td>Commerically available</td>
<td>Supply management</td>
</tr>
<tr>
<td>D5W + 0.45% sodium chloride + 40 mmol KCl/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5W + 0.9% saline + 20 mmol KCl/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5W + 0.9% saline + 40 mmol KCl/L</td>
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<td></td>
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<tr>
<td>D5W + 20 mmol KCl/L</td>
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<td>D5W + 40 mmol KCl/L</td>
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<td>Normal saline + 20 mmol KCl/L</td>
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<td>Normal saline + 40 mmol KCl/L</td>
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<tr>
<td>Lactated ringers + 20 mmol KCl/L</td>
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<td></td>
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<tr>
<td>Lactated ringers + 40 mmol KCl/L</td>
<td></td>
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<tr>
<td><strong>Term neonates</strong></td>
<td>Pharmacy or nursing prepared</td>
<td>Pharmacy or Add Dextrose to commercial product</td>
</tr>
<tr>
<td>D10W + 0.45% sodium chloride + 20 mmol KCl/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D10W + 0.45% sodium chloride + 40 mmol KCl/L</td>
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<tr>
<td><strong>Preterm neonates</strong></td>
<td>Pharmacy prepared</td>
<td>Supply management</td>
</tr>
<tr>
<td>D10W + 0.2% sodium chloride + 20 mmol KCl/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D10W + 0.2% sodium chloride + 40 mmol KCl/L</td>
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<tr>
<td>D10W + 0.2% sodium chloride + 60 mmol KCl/L</td>
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<tr>
<td>D10W + 0.2% sodium chloride + 80 mmol KCl/L (stock at FMC U55 only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5W + 0.2% sodium chloride + 20 mmol KCl/L</td>
<td>Commerically available</td>
<td></td>
</tr>
<tr>
<td>D5W + 0.2% sodium chloride + 40 mmol KCl/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intermittent infusions:</strong></td>
<td></td>
<td>Pharmacy</td>
</tr>
<tr>
<td>KCl 20 mmol in 100 mL sterile water</td>
<td>Commerically available</td>
<td></td>
</tr>
<tr>
<td><strong>Special products for DKA:</strong></td>
<td></td>
<td>Pharmacy</td>
</tr>
<tr>
<td>Potassium phosphate preparations are no longer supplied by Pharmacy for DKA. If IV phosphate is required it should be administered separately as Sodium Phosphate (see monograph)</td>
<td></td>
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</tbody>
</table>
Section 2: Hyperkalemia

Hyperkalemia is defined as a serum K+ greater than age-specific upper limit of normal
The reference range for serum potassium is:

1 day – 3 months = 4.0 – 6.2 mmol/L
4 months – 11 months = 3.7 – 5.6 mmol/L
Older than 1 year = 3.3 – 5.1 mmol/L

CLINICAL SIGNS OF HYPERKALEMIA

ECG changes are the most reliable.

- Serum K+ 5.5 – 7.0 mmol/L – tall peak T waves
- Serum K+ greater than 7.0 mmol/L - widening QRS complex, P waves disappear
- Serum K+ greater than 8.0 mmol/L – sine wave rhythm
- Neonates and infants have higher upper normal limits than older children and adults, and are more resistant to the ECG changes caused by an elevated serum potassium concentration. This does not mean one can be complacent in treating neonates and infants effectively.
- There are no reliable clinical signs of hyperkalemia.
- The most common cause of an elevated K+ is an inappropriately collected sample (usually a capillary sample with excessive squeezing or the prolonged application of a venous tourniquet). Recheck the potassium concentration if the high K+ does not fit the clinical picture. However, do not delay effective treatment for hyperkalemia if there are ECG changes consistent with hyperkalemia.
- Treatment for hyperkalemia can be divided into temporary measures to prevent cardiac arrest, and definitive treatment to deplete total body potassium. Do not confuse the two.

NOTE: If hyperkalemia is suspected stop all potassium intake and all potassium retaining drugs (e.g. spironolactone, ACE inhibitors) orally and IV if safe to do so.

The Intensive Care Attending should be consulted if hyperkalemia with ECG changes and/or risk of clinical sequelae is suspected.
TREATMENT OF HYPERKALEMIA

Emergency Treatment - Transfer to PICU
Temporary Measures Only - Do Not Delay Definitive Treatments

With dangerous ECG changes – e.g. wide complex arrhythmia:

1. **Ca gluconate** 10% (0.23 mmol/mL of elemental Ca) 60 – 100 mg/kg (0.6 – 1 mL/kg to a maximum of 3 g = 30 mL) direct IV over 5 minutes, in an attempt to prevent arrest. Consider repeating until ECG improves. (Onset: less than 5 mins., duration: 30-60 mins).

   \[ \text{Note: This is an emergency and a large peripheral vein can be used if no central line in place} \]

With less serious ECG changes or without ECG changes:

2. **Nebulized salbutamol solution** (Infants 2.5 mg, Children 5 mg) using 100% oxygen at 8-12 Lpm. or IV salbutamol 4 micrograms/kg over 20 minutes. Can be repeated as required. Beware of lactic acidosis.

3. **Insulin and Dextrose**: Administer 0.5-1 g/kg (2 to 4 mL/kg) of 25% dextrose combined with regular insulin, therefore 1 unit of regular insulin for every 4-5 g of dextrose and infuse over 2 hours OR as an alternative 0.5-1 g/kg (2-4 mL/kg) of dextrose 25% infused over 15-30 minutes followed by 0.1 unit/kg of regular insulin SC or IV (Onset: 20-30 mins).

   \[ \text{Note 1: Differences between Pediatrics and Neonatal dosing.} \]
   \[ \text{Note 2: In an emergency 25% dextrose may be administered slowly via a large peripheral vein (maximum is 12.5%)} \]

**NOTE**: 2 and 3 may have additive effect

If acidic or if unknown acid-base status:

4. **Sodium bicarbonate** 8.4% (1 mmol/mL) or 4.2% (0.5 mmol/mL): Administer 1-2 mmol/kg, (1 mL of 8.4% sodium bicarbonate = 1 mmol NaHCO₃) diluted in 2 x volume of H₂O for injection over 15 minutes. (Onset: less than 5 minutes, Duration: 15-30 minutes) – Unproven Benefit

   \[ \text{Definitive Treatments} \]
   \[ \text{(Do not delay – other methods of control are temporary only)} \]

1. **Diuretics**: Administer a loop diuretic (furosemide) IV at a dose appropriate for the renal function either as an intermittent infusion or continuous infusion. Normally 0.5-1 mg/kg, MAX 40 mg, higher dose may be tried in renal failure or if previous diuretic exposure. (Onset: 1 hour). Consider furosemide infusion at 0.1-0.5 mg/kg/hr. Higher rates of infusion have been associated with SVT.

   \[ \text{NOTE: 2 and 3 may have additive effect} \]

2. If no urine output, then removal of potassium can be achieved by Sodium polystyrene sulphonate. Onset of action is delayed for hours and thus it is advised that sodium polystyrene sulphonate NOT be used to treat symptomatic hyperkalemia. Use should be limited to treatment of asymptomatic
mild hyperkalemia in the chronic setting e.g. chronic renal failure. Refer to Pediatric Lexicomp monograph for dosing and administration guidelines.

3. Dialysis/Haemofiltration: This is the best definitive treatment and should not be delayed.

ADDITIONAL COMMENTS

- Sodium polystyrene sulphonate is not appropriate therapy for severe hyperkalemia when used alone.
- Use of succinylcholine (paralysing agent) is contraindicated in the presence of hyperkalemia.
- The clinical effects of hyperkalemia are potentiated by simultaneous digoxin toxicity.

References

3. In 2012 a child had a brief hyperkalemic arrest (K+ 10 mmol/L) when 2 mmol/kg of KCl was given orally during an intermittent infusion of 1 mmol/kg over 2 hrs.