**Summary**

- **Key:**
  - General Notes
  - GP/SWASFT
  - ED/MAU/SRU/Acute GP/Amb-Care
  - In-patient wards

**Start**

- **Normal range:** 3.5 – 5.2 mmol/L

- **K⁺ <2.5 mmol/L**
  - Give the maximum safe dose IV over 24 hours*

- **K⁺ 2.5 – <3.0mmol/L**
  - ECG changes or history of cardiovascular condition or condition acute? [Yes/No]

  - Yes
    - Check potassium every 2 days until normalised
  - No
    - 80-120mmol potassium IV over 24 hours

- **K⁺ 3.0 - 3.5 mmol/L**
  - Considering dietary changes
  - Replace total body deficit over 3-5 days using oral supplements where possible. Usually about 80 mmol potassium a day

**End**

---

*The maximum safe dose that can be given in 24 hours = 3mmol/kg (assuming normal renal function)*

*Check other electrolyte levels, particularly magnesium and phosphate*

Clinical Guideline for the Management of Hypokalaemia
1. **Aim/Purpose of this Guideline**

   This guideline has been written to inform doctors, pharmacists and nursing staff and provide a reference in the management of hypokalaemia in adults.

2. **Hypokalaemia**

2.1. **What is hypokalaemia?**

   2.1.1. Hypokalaemia is defined as a serum potassium level of less than 3.5 mmol/L. Severe hypokalaemia is a level of less than 2.5 mmol/L.

2.2. **Causes of hypokalaemia**

   2.2.1. Hypokalaemia can result from decreased potassium intake, increased losses or shifts in intracellular and extracellular distribution. Common causes of these are as follows:

   - Decreased intake:
     - Inadequate dietary potassium intake (e.g. alcoholism, anorexia)
   - Increased losses (split to renal and gastro losses)
     - Prolonged diarrhoea**
     - Vomiting**
     - Excessive use of laxatives

   - Gastrointestinal
     - Prolonged diarrhoea**
     - Vomiting**
   - Renal
     - Diuretic therapy*
     - Urinary loss in congestive heart failure
     - Hypomagnesaemia
     - Bartter syndrome
     - Primary or secondary hyperaldosteronism
     - Cushings syndrome or disease
     - Liddle syndrome
     - Ectopic ACTH
     - Large doses of corticosteroids

   - Shifts in distribution
     - B2-agonists (e.g. salbutamol)
     - Theophylline
     - Insulin

   *most common cause    ** other common causes

2.3. **Signs and Symptoms**

   2.3.1. Dependant on potassium level – see below:

   **3.0 – 3.5mmol/L** – Usually asymptomatic. Malaise, weakness, constipation, muscle cramps, fatigue can occur. ECG changes including a flat or inverted T wave, ST segment depression and prominent U waves.
2.5 – <3.0mmol/L - As above but more pronounced. Muscle necrosis, arrhythmias in patients with underlying cardiac problems.

<2.0mmol/L - Cardiac arrhythmias, paralysis of legs and respiratory muscles, rhabdomyolysis, myoglobinuria, acute renal failure.

2.4. **Information required to assess the situation**

1. Potassium level
2. Is it an acute or chronic condition?
3. Any underlying medical conditions? particularly hypertension, congestive heart failure, arrhythmias, renal failure, diabetes mellitus, stroke, metabolic acidosis or alkalosis
4. Possible causes? (see section 2.2). Consider potential drug causes and check magnesium levels. Note: Can exclude renal causes if urinary potassium <20mmol/L (except in polyuria).
5. Has any treatment already occurred?
6. What is the current potassium intake?
7. Patient’s approximate weight
8. Is the patient symptomatic?

3. **Guidance**

3.1. 90% of potassium is intracellular, therefore a small drop in serum (extracellular) potassium can represent a much larger drop in terms of the total body potassium content (normally approximately 3500mmol). However, serum potassium levels are not always representative of total body potassium content. Therefore it is always necessary to consider the clinical state of the patient and any diseases that may be causing potassium to shift from the intracellular to extracellular space. Potassium levels within the cells are maintained by a sodium-potassium pump providing an intracellular cation ratio of 1:10.

3.2. A potassium deficiency is calculated according to the equation below

\[ K \text{ (mmol/L)} = BW \text{ (kg) } \times 0.2 \times 2 \times (4.5 - \text{actual serum potassium (mmol/L)}) \]

(The extracellular volume is calculated from the body weight (kg) x 0.2)

3.3. This provides you with the amount of potassium that you need to give to correct the levels. It has been demonstrated that there is an association between potassium and magnesium deficiencies. A patient with a low potassium level should have magnesium levels checked as it can be very difficult to correct hypokalaemia in the presence of hypomagnesaemia.

3.4. The normal daily requirement of potassium of 50-100mmol per day also needs to be considered when supplementing potassium.

3.5. A normal dose of 1mmol/kg/day may be considered.

3.6. The maximum safe dose that can be given in 24 hours = 3mmol/kg (assuming normal renal function).
3.7. Potassium is available as three salts: potassium chloride, potassium phosphate and potassium bicarbonate.

3.7.1. Potassium phosphate is the main salt found in food.

3.7.2. Potassium chloride should be used for supplementation because of its unique effectiveness against the most common causes of potassium depletion.

3.7.3. Potassium bicarbonate may be considered for use in potassium depletion associated with metabolic acidosis (this is not available at RCHT).

4. Concentrations

4.1. Potassium chloride administered peripherally should be diluted in sodium chloride or other suitable diluent.

4.2. High concentrations of potassium can cause serious cardiotoxicity, therefore it is therefore recommended that the concentration of the solution should not exceed 3g (40mmol)/L and the diluted solution given slowly. Higher concentrations have been given in suitable areas when administered with caution.

4.3. Central

4.3.1. Potassium can be infused neat (2mmol/ml). Neat potassium is only available in certain critical areas in the hospital.

4.4. Peripheral

4.4.1. 40mmol/L is usually recommended as the maximum concentration for peripheral infusion. However, one study recorded giving up to 200mmol/L peripherally in over 100 patients with a low incidence of phlebitis. In this hospital the most concentrated preparation available is 80mmol/L and this is the maximum concentration that should be recommended for peripheral use, it should be advised that this is infused into a large vein with close monitoring of the site.

4.5. Subcutaneous

4.5.1. Maximum of 40mmol per litre may be infused.

5. Rate of Infusion

5.1. Rate of potassium infusion is 10-20mmol/hour. In rates higher than 10mmol/hour it is preferable that ECG monitoring is used.

6. Further Information and Special Instructions

6.1. Patients with cardiac arrhythmias

6.1.1. Aim to keep potassium levels at around 4.0mmol/L, even a small drop in potassium level should be treated. The co-administration of
magnesium should be considered to facilitate the cellular uptake of potassium.

6.2. **Patients with congestive heart failure**
6.2.1. High risk of arrhythmias if potassium level drops low. These patients are also quite likely to be on diuretics and digoxin. Monitor potassium levels regularly.

6.3. **Patients with diabetes mellitus**
6.3.1. Potassium levels should be closely monitored in diabetic patients due to the adverse effects of insulin and dextrose on potassium levels and the risk of metabolic acidosis.

6.4. **Patients taking angiotensin-converting enzyme inhibitors and angiotensin II receptor antagonists:**
6.4.1. Patients taking ACE-inhibitors or angiotensin II receptor antagonists, especially those with impaired renal function, should be closely monitored, as the potassium sparing effect in combination with potassium infusion may result in overcorrection to hyperkalaemia.

6.5. **Patients taking digoxin**
6.5.1. Hypokalaemia increases digoxin toxicity by sensitising the myocardium to the actions of cardiac glycosides.

6.6. **Patients taking ciclosporin**
6.6.1. Ciclosporin can cause the retention of potassium; therefore the concurrent use of ciclosporin with potassium infusions may result in overcorrection to hyperkalaemia.

6.7. **Glucose infusions:**
6.7.1. Concomitant use of glucose infusions in hypokalaemic patients may cause a further decrease in plasma potassium concentrations.

6.8. **Patients with hypertension**
6.8.1. Aim to keep potassium levels at around 4.0mmol/L, even a small drop in potassium level should be treated.

6.9. **Patients taking potassium sparing diuretics:**
6.9.1. Potassium supplements should not be administered with potassium sparing diuretics (such as amiloride, spironolactone and triamterene), particularly in patients with impaired renal function. Any patients on this combination require close monitoring in order to diagnose a potential hyperkalaemic condition as soon as possible.

6.10. **Patients with metabolic disturbances**
6.10.1. Acidotic and alkalotic patients have shifts of potassium. In acidosis potassium shifts from the intracellular space to extracellular space therefore the serum potassium appears elevated while total body potassium is severely depleted. In alkalosis the opposite occurs.
6.10.2. Correction for acidosis or alkalosis:

\[
(7.4 - \text{actual pH}) \times 0.6 \text{mmol/L} = \text{adjustment factor} \\
0.1
\]

(Potassium level of patient (mmol/L) – adjustment factor (mmol/L)) = corrected potassium level for metabolic acidosis or alkalosis.

6.11. Patients with renal impairment

6.11.1. Data suggests a link between potassium levels and lesions of the kidneys in patients with renal disease or diabetes. Animal studies suggest that potassium may offer a protective effect on the renal arterioles.

6.12. Patients prone to stroke

6.12.1. The benefits of potassium in stroke are not clearly known though there seems to be a correlation with high dietary intake and a reduced risk of stroke. It is therefore advisable to try and maintain optimal levels of potassium in those at risk of either ischaemic or haemorrhagic stroke.

7. Monitoring compliance and effectiveness

<table>
<thead>
<tr>
<th>Element to be monitored</th>
<th>Compliance with the clinical guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>Medication Safety Pharmacist</td>
</tr>
<tr>
<td>Tool</td>
<td>Periodic clinical audit, Incident reports via DATIX system</td>
</tr>
<tr>
<td>Frequency</td>
<td>When incident reports are received Yearly otherwise</td>
</tr>
<tr>
<td>Reporting arrangements</td>
<td>The completed report to be sent to the Medication Safety Group for review</td>
</tr>
<tr>
<td>Acting on recommendations and Lead(s)</td>
<td>The Medication Safety Group will report any necessary actions to the Medicines Practice Committee</td>
</tr>
<tr>
<td>Change in practice and lessons to be shared</td>
<td>Required changes to practice will be identified and actioned within 3 months. A lead member of the team will be identified to take each change forward where appropriate. Lessons will be shared with all the relevant stakeholders</td>
</tr>
</tbody>
</table>

8. Equality and Diversity

8.1. This document complies with the Royal Cornwall Hospitals NHS Trust service Equality and Diversity statement which can be found in the ‘Equality, Diversity & Human Rights Policy’ or the Equality and Diversity website.

8.2. Equality Impact Assessment

The Initial Equality Impact Assessment Screening Form is at Appendix 2.
9. Appendix 1: Governance Information

<table>
<thead>
<tr>
<th>Document Title</th>
<th>Clinical Guideline for the Management of Hypokalaemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Issued/Approved:</td>
<td>October 2016</td>
</tr>
<tr>
<td>Date Valid From:</td>
<td>October 2016</td>
</tr>
<tr>
<td>Date Valid To:</td>
<td>April 2018</td>
</tr>
<tr>
<td>Directorate / Department responsible (author/owner):</td>
<td>Victoria Ling, Medicines Information Maggie Fitzgerald, Medicines Information</td>
</tr>
<tr>
<td>Contact details:</td>
<td>01872 252587</td>
</tr>
<tr>
<td>Brief summary of contents</td>
<td>This guideline provides guidance on the appropriate management of hypokalaemia</td>
</tr>
<tr>
<td>Suggested Keywords:</td>
<td>Hypokalaemia, Potassium</td>
</tr>
<tr>
<td>Executive Director responsible for Policy:</td>
<td>Medical Director</td>
</tr>
<tr>
<td>Date revised:</td>
<td>N/A</td>
</tr>
<tr>
<td>This document replaces (exact title of previous version):</td>
<td>New Document</td>
</tr>
<tr>
<td>Approval route (names of committees)/consultation:</td>
<td>Medicines Practice Committee (October 2016)</td>
</tr>
<tr>
<td>Divisional Manager confirming approval processes</td>
<td>Karen Jarvill</td>
</tr>
<tr>
<td>Name and Post Title of additional signatories</td>
<td>Not Required</td>
</tr>
<tr>
<td>Name and Signature of Divisional/Directorate Governance Lead confirming approval by specialty and divisional management meetings</td>
<td>{Original Copy Signed}</td>
</tr>
<tr>
<td>Signature of Executive Director giving approval</td>
<td>{Original Copy Signed}</td>
</tr>
<tr>
<td>Publication Location (refer to Policy on Policies – Approvals and Ratification):</td>
<td>Internet &amp; Intranet ✓ Intranet Only</td>
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<td>Clinical / Pharmacy</td>
</tr>
<tr>
<td>Date</td>
<td>Version No</td>
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<tr>
<td>May 2016</td>
<td>V1.0</td>
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This document is to be retained for 10 years from the date of expiry.

This document is only valid on the day of printing

Controlled Document
This document has been created following the Royal Cornwall Hospitals NHS Trust Policy on Document Production. It should not be altered in any way without the express permission of the author or their Line Manager.
10. Appendix 2: Initial Equality Impact Assessment Form

<table>
<thead>
<tr>
<th>Name of Name of the strategy / policy / proposal / service function to be assessed (hereafter referred to as policy) (Provide brief description):</th>
<th>Directorate and service area: Pharmacy</th>
<th>Is this a new or existing Policy? New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of individual completing assessment: Liam Kelly</td>
<td>Telephone: 01872 252587</td>
<td></td>
</tr>
</tbody>
</table>

1. Policy Aim*
Who is the strategy / policy / proposal / service function aimed at?
This guideline has been written to inform doctors, pharmacists and nursing staff and provide a reference in the management of hypokalaemia in adults

2. Policy Objectives*
Guide the management of hypokalaemia

3. Policy – intended Outcomes*
Guide hypokalaemia management

4. *How will you measure the outcome?
Monitoring incident reports

5. Who is intended to benefit from the policy?
Doctors, pharmacists, nurses, patients

6a) Is consultation required with the workforce, equality groups, local interest groups etc. around this policy?
Yes

b) If yes, have these *groups been consulted?

C). Please list any groups who have been consulted about this procedure.

7. The Impact
Please complete the following table.

<table>
<thead>
<tr>
<th>Are there concerns that the policy could have differential impact on:</th>
<th>Yes</th>
<th>No</th>
<th>Rationale for Assessment / Existing Evidence</th>
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</thead>
<tbody>
<tr>
<td>Equality Strands:</td>
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</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (male, female, trans-gender / gender reassignment)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Race / Ethnic communities /groups</td>
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<td></td>
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</tr>
</tbody>
</table>

Clinical Guideline for the Management of Hypokalaemia

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**Disability -**
Learning disability, physical disability, sensory impairment and mental health problems  

**Religion / other beliefs**

**Marriage and civil partnership**

**Pregnancy and maternity**

**Sexual Orientation, Bisexual, Gay, heterosexual, Lesbian**

You will need to continue to a full Equality Impact Assessment if the following have been highlighted:
- You have ticked “Yes” in any column above and
- No consultation or evidence of there being consultation - this excludes any policies which have been identified as not requiring consultation. or
- Major service redesign or development

8. Please indicate if a full equality analysis is recommended.  | **Yes** | **No** |
--- | --- | --- |

9. If you are not recommending a Full Impact assessment please explain why.

This policy applies to all adult patients

**Signature of policy developer / lead manager / director**  
**Date of completion and submission**

**Names and signatures of members carrying out the Screening Assessment**
1. Liam Kelly  
2. 

Keep one copy and send a copy to the Human Rights, Equality and Inclusion Lead, c/o Royal Cornwall Hospitals NHS Trust, Human Resources Department, Knowledge Spa, Truro, Cornwall, TR1 3HD

A summary of the results will be published on the Trust’s web site.

Signed ______________________________  
Date ______________________________

Clinical Guideline for the Management of Hypokalaemia

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