1. Guidelines for the Management of Acute Hypokalaemia in Adults

1.1. Scope

This guideline applies to all medical staff, all agency staff and bank staff and staff with honorary contracts working on clinical wards throughout HDFT.

1.2. Procedure / Guideline

The HDFT reference range for serum potassium 3.5 to 5.3 mmol/L.

Table 1 - Serum Potassium Classification

Normal (3.5-5.3 mmol/L)	Mild (3.0-<3.5 mmol/L)	Moderate (2.5-2.9 mmol/L)	Severe (<2.5 mmol/L)

Causes of Hypokalaemia:

Most commonly, hypokalaemia will result from intestinal loss (e.g. diarrhoea) or renal loss (e.g. metabolic alkalosis). However there are several drugs which can cause a decrease in potassium levels including;

- Thiazide diuretics (e.g. bendroflumethiazide) and loop diuretics (e.g. furosemide)
- Amphotericin, cisplatin
- Aminoglycosides (e.g. amikacin, gentamicin)
- Beta-agonists (e.g. salbutamol, terbutaline)
- Insulin treatment (e.g. in the treatment of diabetic ketoacidosis)
- Corticosteroids (e.g. fludrocortisone, hydrocortisone)
- Caffeine, theophylline
- Adrenaline, pseudoephedrine
- High dose penicillin

Signs and Symptoms of Hypokalaemia

Hypokalaemia is found in over 20% of hospitalised patients. Symptoms do not generally manifest until the serum potassium is <3.0 mmol/L, unless the serum potassium falls rapidly or the patient has a potentiating factor, such as a predisposition to arrhythmia due to the use of digitalis. This document is a guideline and treatment should be commenced based on the clinical picture.

Serum potassium concentration	Potential symptoms
3.0-3.5 mmol/L	Usually no symptoms, *arrhythmias
2.5-2.9 mmol/L	Generalised weakness, lassitude and constipation, *arrhythmias
2.0-2.4 mmol/L	Muscle weakness and necrosis, *arrhythmias
Less than 2.0 mmol/L	Paralysis and impairment of respiratory function, *arrhythmias
*In patients with ischaemic heart disease, heart failure, or left ventricular hypertrophy, even mild hypokalaemia increases the likelihood of arrhythmias. (Table from UKMI/Leeds Guidelines)	

Severity of the condition depends on serum potassium level and the rate of decline, associated and/or comorbid conditions and treatment with digoxin or antiarrhythmic drugs.

Treatment of hypokalaemia

Aims of Treatment

- To prevent or treat life-threatening complications (arrhythmias, paralysis, rhabdomyolysis, and diaphragmatic weakness)
- To rapidly raise the serum potassium concentration to a safe level and then replace the remaining deficit at a slower rate over days to weeks
- To diagnose and correct the underlying cause

Patient Groups Where Hypokalaemia Should be Avoided

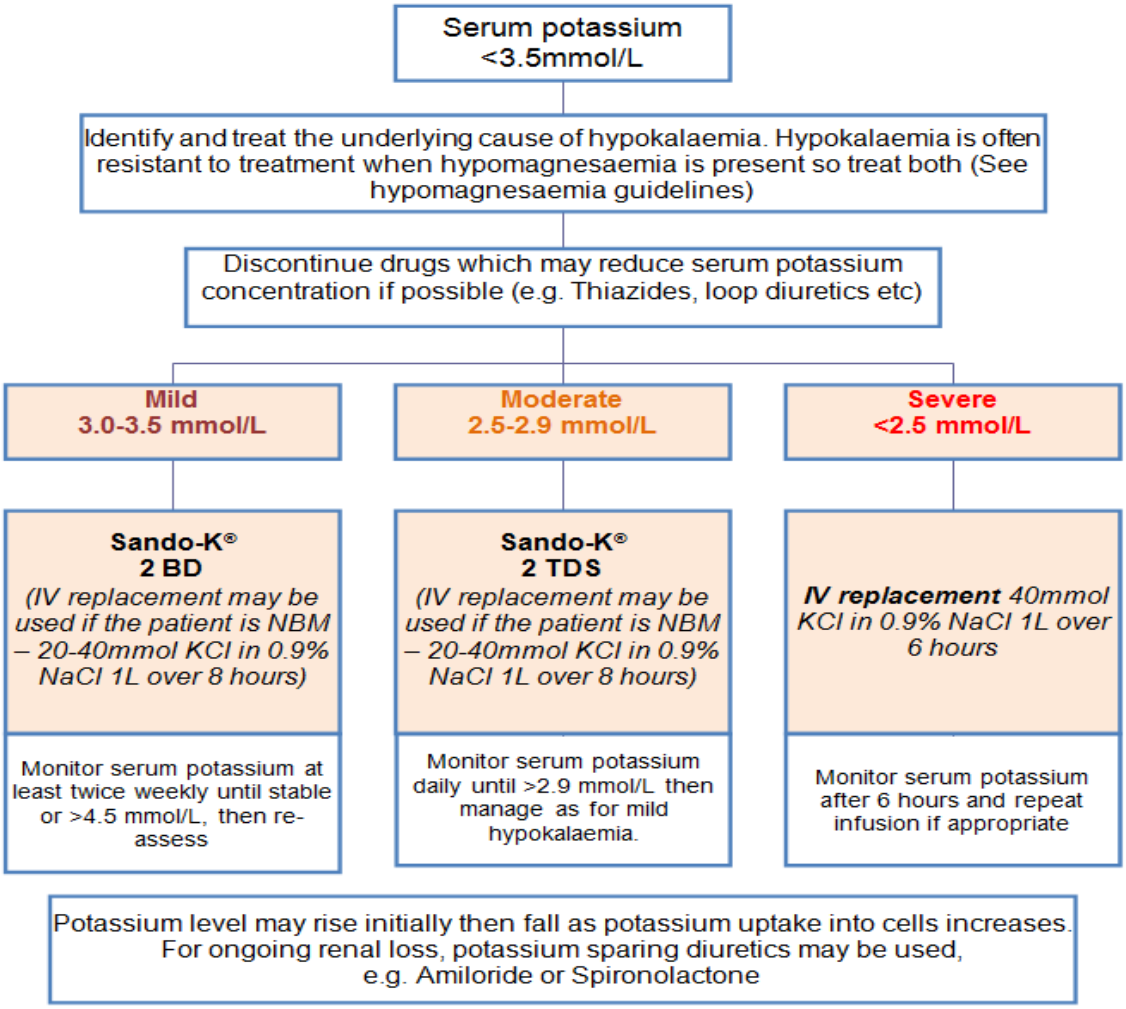
Due to the risk of morbidity and mortality, the underlying cause of clinical hypokalaemia should be identified and treated. Maintenance of normal potassium levels is particularly important for:

- Patients taking digoxin or other anti-arrhythmic drugs; hypokalaemia increases the risk of digoxin toxicity and its arrhythmogenic potential
- Patients with hypoaldosteronism secondary to renal artery stenosis, liver cirrhosis, nephrotic syndrome and severe heart failure
- Patients with excessive loss of potassium in the faeces e.g. chronic diarrhoea
- Patients who are nil by mouth or those receiving total parenteral nutrition

Chronic hypokalaemia indicates a profound deficit in total body potassium and replacement may take several days. Failure to correct hypokalaemia despite appropriate treatment may be due to underlying hypomagnesaemia

Table 2 -Treatment Flowchart

This monograph aims to provide guidance only. The dose of potassium to correct hypokalaemia must be established on an individual patient basis.



Adapted from Clinical Guideline for the Treatment of Hypokalaemia in adults. Leeds Teaching Hospitals NHS Trust

Oral Potassium Replacement Therapy:

Preparation	K^+ mmol	Dose	Comments
Sando-K	*12mmol/tab*	*1-4 TDS/QDS*	*8mmol/tab Cl^-*
Potassium chloride 7.5% Syrup	*1mmol/ml*	*10ml TDS*	*1mmol/ml Cl^-* Can be more palatable than dispersible Sando-K
Potassium chloride 600mg MR tablets	*8mmol/tab*	*2-3 TDS/QDS*	*8 mmol/tab Cl-* *Avoid MR preparation due to risk of gastric ulceration – give with meals if only option*

Intravenous Potassium Replacement Therapy:

Preparation	K^+ mmol	Dose	Comments
Potassium chloride 0.15% in Sodium chloride 0.9% (1L)	*20mmol/L*	*Infuse over 6-8 hours*	
Potassium chloride 0.3% in Sodium chloride 0.9% (1L)	*40mmol/L*	*Infuse over 6-8 hours*	
Potassium chloride 0.45% in Sodium chloride 0.9% (1L)	*60mmol/L*	*Infuse over 6-8 hours*	*ONLY use if HDU bed unavailable. ECG monitoring required*

Intravenous (IV) therapy is indicated in the following situations:

- Patients with serum potassium concentration of less than 2.5 mmol/L
- Patients with symptoms of hypokalaemia
- Patients who are nil by mouth
- Patients who are unable to tolerate oral administration
- Patients who are unlikely to absorb oral potassium

Precautions for IV potassium use:

- Intravenous potassium is very irritant and rapid administration can be cardiotoxic. If pain occurs, reduce the rate or concentration
- Ready-made diluted potassium infusions containing 10-40mmol of potassium per litre can be given by a peripheral venous catheter. Ensure the bag is shaken well before and during administration. The rate of intravenous infusion of ready-made diluted potassium via a peripheral venous catheter should not exceed 20mmol/hour.
- Concentrations greater than 40mmol of potassium per litre **must always** be given via a central venous access device, using a suitable infusion pump. Ensure the bag is shaken well before and during administration. Ready-made solutions should be used wherever possible. The usual maximum rate is 20mmol/hour but in circumstances when higher rates are administered continuous ECG monitoring is needed.

- Only ready-made bags must be used in non-intensive care clinical areas. Potassium chloride 50mmol in 50mL syringes are for use in ITU/HDU only

ONLY USE READY MIXED IV POTASSIUM
NEVER ADD TO A PRE-MADE BAG
(Potassium Chloride Syringes 50mmol in 50mL are for ITU/HDU USE ONLY)

Adverse Drug Reactions

Excessive doses of potassium may lead to the development of hyperkalaemia, particularly in patients with renal impairment. Symptoms include

- paraesthesia of the extremities
- muscle weakness
- paralysis
- confusion
- cardiac arrhythmias*
- heart block*
- cardiac arrest*

(*cardiac toxicity is of particular concern after IV dosage)

Other adverse reactions include:

- Pain, phlebitis or serious injury following intravenous administration via peripheral veins, particularly at higher concentrations
- Nausea, vomiting, diarrhoea, and abdominal cramps (with oral therapy)

Interactions

Potassium supplements should be used with caution in patients receiving drugs that increase serum potassium concentrations. These include:

- potassium-sparing diuretics (e.g. spironolactone, amiloride, triamterene, co-amilofruse, co-amilozide)
- ACE inhibitors (ACEI) (e.g. ramipril, lisinopril)
- angiotensin II receptor antagonists (e.g. irbesartan, losartan, candesartan)
- tacrolimus
- ciclosporin
- drugs that contain potassium such as the potassium salts of penicillin

Cautions to potassium replacement therapy

- Severe renal impairment (exercise extreme caution and monitor frequently)
- Renal insufficiency (lower doses of replacement therapy may be required for patients with renal disease)
- Concomitant ACEI or potassium-sparing diuretic therapy

2. CONSULTATION, APPROVAL AND RATIFICATION PROCESS

This Guideline has been consulted on with the key stakeholders identified in Appendix 1.

This Guideline will be approved by the HaRD Area Prescribing Committee

3. DOCUMENT CONTROL

The Guideline will be published on the Trust electronic document library.

The pharmacy document library administrator will be responsible for archiving previous versions and replacing with the current ratified version.

4. DISSEMINATION AND IMPLEMENTATION

The new Guideline will be rolled out through existing meeting structures (e.g. Pharmacy staff meeting) and an all user email. Ward pharmacists will brief their clinical teams as necessary.

5. MONITORING COMPLIANCE AND EFFECTIVENESS

An audit will be carried out in order to assess compliance.
An audit will be carried out in order to assess effectiveness.

6. REFERENCE AND ASSOCIATED DOCUMENTS

Barth, JH., Butler, GE., Hammond, P., Biochemical Investigations in Laboratory Medicine, 2001. ACB Venture Publications, London

BMJ Group, BNF: British National Formulary, April 2014, online edition. The Pharmaceutical Press, London. (Date Accessed 05/02/2018)

Knochel JP. Neuromuscular manifestations of electrolyte disorders. Am J Med. 1982;72(3):521

Leeds Teaching Hospitals NHS Trust. Clinical Guideline for the Treatment of Hypokalaemia in adults. Issue date Jan 2013.

Medusa Injectable Medicines Guide. Available at http://medusa.wales.nhs.uk (Date accessed 05/02/2018)

Mujais, SK., Katz, AL., Potassium deficiency. In: The Kidney: Physiology and Pathophysiology, Seldin DW, Giebisch G (Eds), Lippincott Williams & Wilkins, 2000. p.1615.

NHS Greater Glasgow and Clyde. Therapeutics . A Handbook for Prescribing in Adults.
2012: 288-9.

NHS Specialist Pharmacy Services, UKMI (2017) How is hypokalaemia treated in adults? *https://www.sps.nhs.uk/articles/how-is-hypokalaemia-*

treated-in-adults/

NPSA, Potassium solutions: risks to patients from errors occurring during intravenous administration, 2002. Available at *http://www.nrls.npsa.nhs.uk/resources/?EntryId45=59882*

Rose, BD, Post, TW. Hypokalaemia. In: Clinical physiology of acid-base and electrolyte disorders, 5th ed, Rose, BD, Post, TW (Eds), McGraw-Hill, 2001. p.836

Summary of Product Characteristics. Electronic Medicines Compendium. Datapharm Communications Ltd. (HK Pharma Limited, Sando-K). https://www.medicines.org.uk/emc/ medicine/812/SPC/Sando-K/ (date accessed 05/02/2018; date last updated: September 2014)

Summary of Product Characteristics. Electronic Medicines Compendium. Datapharm Communications Ltd. (Alliance Pharmaceuticals, Slow-K). https://www.medicines.org.uk/emc/ medicine/130/SPC/Slow-K+Tablets+600+mg/ (date accessed 05/02/2018; date last updated: March 2012)

Adapted from previous guidelines by: Kathryn Hornsby (original guidelines written by Mat Croft)

7. APPENDICES

Appendix 1: Consultation Summary
Appendix 2: Monitoring, audit and feedback summary

7.1. Consultation Summary

Those listed opposite have been consulted and any comments/actions incorporated as appropriate. The author must ensure that relevant individuals/groups have been involved in consultation as required prior to this document being submitted for approval.	**List Groups and/or Individuals Consulted**
	Dr Jassam – Consultant Clinical Biochemist
	HaRD Area Prescribing Committee

7.2. Monitoring, Audit and Feedback Summary

KPIs	Audit / Monitoring required	Audit / Monitoring performed by	Audit / Monitoring frequency	Audit / Monitoring reported to	Concerns with results escalated to
Audit of adherence to the guidelines	Audit on adherence to the guidelines	Pharmacy staff or medical staff	Every 2 years	Audit Committee Author of guideline Pharmacy staff	Improving Patient Safety Steering Group
Audit of effectiveness of the guidelines	Audit of effectiveness of the guidelines	Pharmacy staff or medical staff	Every 2 years	Audit Committee Author of guideline Pharmacy staff	Improving Patient Safety Steering Group