University Hospitals of Leicester NHS
NHS Trust

Potassium Solutions for Intravenous Administration Including guideline for Hypokalaemia UHL Policy

Approved By:	Policy & Guideline Committee
Date of Original Approval:	9 January 2018 (PGC Chair's approval)
Trust Reference:	**B1/2018**
Version:	3
Supersedes:	2 – August 2019 Policy and Guideline Committee
Trust Lead:	Elizabeth McKechnie, Medication Safety Pharmacist
Board Director Lead:	Medical Director
Date of Latest Approval	15 March 2024 – Policy and Guideline Committee
Next Review Date:	**May 2027**

CONTENTS

REVIEW DATES AND DETAILS OF CHANGES MADE DURING THE REVIEW

Dec 2023 : minor changes. Review of high strengths and where they are kept with an addition made for ED Resus to keep the 40mmol in 100ml bags.

5.1.4 added to state other bags must be stored separate from other fluids and labelled in Red

KEY WORDS

Potassium, hypokalaemia, concentrated ampoules

1 INTRODUCTION

1.1 This document sets out the University Hospitals of Leicester (UHL) NHS Trusts Policy for the safe use of potassium for injectable administration.

1.2 Potassium solutions are widely used and administered intravenously to treat low potassium levels (hypokalaemia) in more seriously ill patients.

1.3 Patients in critical care settings may require potassium to be administered immediately in small volumes/ concentrated solutions, where delay may risk cardiac arrest.

1.4 It is well documented that concentrated potassium solutions (undiluted ampoules) if given rapidly will lead to cardiac arrhythmias and death. There have been fatalities reported where potassium concentrate solutions were accidentally used to reconstitute antibiotic bolus injections and then administered rapidly.

1.5 A Patient Safety alert was issued nationally in 2002 concerning the use and storage of Potassium Concentrate solutions, recommending the storage of high concentration potassium injectables in a Controlled drug cupboard.

1.6 An administration error with Concentrated Potassium is listed as one of the Never Events in the Department of Health Never event framework. The definition in the 2015 updated list changed to 'Mis-selection of a strong potassium containing solution'. Mis-selection is defined as 'when a patient intravenously receives a strong potassium solution rather than an intended different medication'.

2 POLICY SCOPE

2.1 The policy applies to all healthcare professionals involved in the prescribing, ordering, supply and administration of injectable potassium to patients across the Trust.

2.2 The guideline for the management of hypokalaemia is only applicable on adult general ward areas.

- For paediatrics please refer to the 'Fluid electrolyte management UHL childrens medical guideline' C6/2015.
- For Critical Care please refer to 'Guideline for the Emergency Treatment of Hypokalaemia on Adult ICU C14/2019

3 DEFINITIONS

3.1 **Designated Critical Care Areas** – areas where concentrated or high strength potassium solutions may be kept and administered.

Areas which have been designated as Critical Care areas under this policy and the concentrated potassium preparations they are allowed to keep are available in appendix two.

3.2 **Concentrated or high strength** Potassium Solutions

'Concentrated or high strength Potassium Solutions' relate to any solutions defined in the Patient Safety Alert on Potassium. These are:

- Potassium chloride 15% (1.5g, 20mmol potassium in 10ml)
- Potassium acid phosphate 13.6% (10 mmol potassium in 10ml)
- Prefilled Potassium syringes 50mmol in 50ml and 10mmol in 20ml

- Sterile Concentrate for Cardioplegia Infusion 5.95% (15.98 mmol potassium in 20ml)
- Sodium Chloride 0.9% Potassium Chloride 3%, containing 40mmol/100ml

3.3 **Formulary** Potassium Infusions (see Appendix One)

These are bags containing potassium diluted to 80mmol/litre or less which are kept in pharmacy, where they are available for use on wards. All new intravenous potassium products must undergo a risk assessment to determine if they should be included in this policy. This is included in the Pharmacy Purchasing for Safety Policy C30/2017

4 ROLES AND RESPONSIBILITIES

4.1 The executive lead responsible for this policy is the Medical Director

4.2 Clinical Management Group (CMGs) Clinical Directors and Heads of Nursing are responsible for:

a) Ensuring that all relevant staff are aware of this policy.

b) Investigating where practice has not followed this policy, ensuring these are reported on Datix.

4.3 Employees

a) All staff have a duty to follow this policy and report any concerns which may impact on the safety for patients.

b) Report any incidents with Potassium through the Trust incident reporting system, Datix.

5 POLICY STATEMENTS

Potassium infusions may be a used for a variety of reasons dependent on the area.

- Pre-mixed bags with the potassium content highlighted in red on the labelling should be purchased where possible.
- the initial treatment for the correction of severe or symptomatic hypokalaemia when sufficient potassium cannot be taken by mouth or when absorption is unpredictable, or where the patient is unable to take sufficient potassium orally.
- Routine hydration for patients where serum potassium may be low for example following chemotherapy.

5.1 Storage

5.1.1 Concentrated Potassium solutions and High Strength potassium infusion bags will only be kept as routine stock within pharmacy departments, and in designated critical care areas. (refer to appendix 2)

5.1.2 The ward stock lists will reflect the strength and quantity of infusions generally used in that area. Only infusions containing less than or equal to 40mmol/L potassium will be supplied without a Controlled drug order book.

5.1.3 Concentrated Potassium solutions and High Strength potassium infusion bags must be kept in the Controlled Drug Cupboard away from sodium chloride, water for injection and other products of a similar appearance.

5.1.4 Other potassium bags containing less than or equal to 40mmol/L potassium must be segregated as much as possible from other fluids and labelled clearly in Red that the bags contain potassium.

5.2 Ordering, Supply and records

5.2.1 Controlled Drug record books must be used to record all receipts and supplies of Concentrated potassium ampoules and High Strength potassium infusions. Products currently available are listed in appendix One

5.2.2 Concentrated Potassium solutions or High Strength potassium infusions can only be supplied to a designated critical area on production of an order in a Controlled Drug Order book (ref Policy and procedure for the management of controlled drugs on wards, departments and theatres B16/2009)

5.2.3 All requests made from clinical areas not designated to hold ward stock (of Concentrated or High Strength potassium injection) must be referred to the CMG lead pharmacist or to the senior pharmacist on call for risk assessment in discussion with the patient's consultant prior to a supply being made. Ideally patients requiring concentrated potassium solutions should be moved to a critical care area on the approved list but in exceptional circumstance this may not be possible.

5.2.4 Concentrated Potassium solutions or High Strength potassium infusions **must not** be transferred between clinical areas but must always be directly ordered from the pharmacy department.

5.2.5 Transfers of High Strength and Concentrated potassium injection between pharmacy departments will be dealt with in accordance with the Pharmacy SOP 905 for Inter-departmental transfer of Controlled drugs.

5.3 Disposal

5.3.1 Concentrated or High Strength potassium injections no longer required on the ward or expired must be returned to pharmacy using the same process as for returning controlled drugs and a witnessed record made in the ward controlled drug record book.

5.3.2 Potassium solutions do not denaturing as controlled drugs do but can be placed in blue bins for destruction.

5.4 Prescribing

5.4.1 The dosage requirements for patients will depend upon the serum potassium and phosphate (in the case of potassium acid phosphate solutions) level, the patient's condition and concurrent therapy.

5.4.2 Glucose containing solutions may reduce serum potassium concentrations, so glucose free solutions may be more suitable for initial IV therapy of hypokalaemia.

5.4.3 Renal impairment: close monitoring required with high risk of hyperkalaemia and avoid in severe renal impairment.

5.4.4 Potassium solutions for IV administration generally should be prescribed in concentrations that are available as commercially pre-mixed infusion bags containing 20mmol/L or 40mmol/L.

5.4.5 Additionally, bags containing 60mmol/L or 80mmol/L are available. These carry higher risks of venous irritation or damage if infused into small peripheral veins and should be reserved for use only where more dilute solutions are clinically inappropriate. Consider infusing these through larger veins (or a central line) if large volumes or prolonged infusion over several days are likely.

5.4.6 Concentrated preparations may be prescribed but only in designated areas (see appendix 2)

5.4.7 The prescription must state the following and written as per Leicestershire medicines code (paper or electronic). A new prescription must be written every 24 hours on ward areas (exception intensive care units)

- Amount of potassium required in mmols
- Salt of potassium to be used eg Potassium Chloride
- The chemical formulae must not be used to prescribe. Ie Must be prescribed as 'potassium chloride' and **NOT KCl**
- The diluent to be used
- The total volume of the infusion
- The total period of time for the infusion, or the infusion rate.

Refer to the injectable guide (Medusa) available on Insite for further information.

5.4.7 Replacement of large volumes of fluid is a potential problem and the fluid balance should be re-assessed frequently by a doctor if large volumes of potassium infusion are required.

5.5 Administration:

5.5.1 Ideally ready-made bags or pre-filled syringes should be used wherever possible rather than preparing using concentrated ampoules.

5.5.2 Any preparation using the concentrated ampoules of potassium must be done using a red tray and kept separate from other preparation of injections and infusions.

5.5.3 In non-specialist areas, peripheral intravenous administration must not exceed a maximum concentration of 40mmol/L potassium.

5.5.4 In exceptional circumstances, for concentrations greater than 40mmol/L, when a central line cannot be used, higher concentrations can be given peripherally providing a large vein is used and that cardiac monitoring is required. The prescriber must assess the risks and benefits to a patient on an individual basis.

5.5.5 **THE CONCENTRATED POTASSIUM CHLORIDE 15% SOLUTION MUST NEVER BE GIVEN UNDILUTED. THIS IS LIKELY TO LEAD TO CARDIAC ARREST OR DEATH.** The prescription must specify the solution and dilution required.

5.5.6 Method of administration is by continuous or intermittent infusion and must be administered via a rate controlled infusion device.

5.5.7 Rate of administration should not normally exceed 20mmol/hr peripherally or 30mmol/hr if given centrally. Cardiac monitoring is essential for rates of 30mmol/hr.

5.5.8 A second practitioner must undertake an **independent** check for correct product, dosage, dilution, mixing and labelling during the preparation of solutions prepared from potassium chloride concentrate and other strong potassium solutions as per

- IV Policy (B25/2010)
- adult intensive care areas the Protocol for the checking of IV drug administration within adult intensive care units (ICU) (C18/2017)

5.5.9 The rate of administration, identification of patient must be checked by the independent checker at the bedside in accordance with the IV Policy (B25/2010).

5.5.10 No additives or other medicines are to be made to any strength of potassium infusions.

5.5.11 Compatibilities if not known should be checked with a pharmacist prior to administration with other infusions connected to the same line. Outside pharmacy opening hours the on call pharmacist should be called for advice.

5.5.12 Potassium solutions are extremely irritant and must be given sufficiently slowly to reduce pain along the vein, with care taken to avoid extravasation. The site of infusion must be checked an hour after starting the infusion and then at a minimum of 4 hourly intervals until the infusion is complete.

5.5.13 Upon completion of the potassium infusion the line should be flushed with sodium chloride 0.9%.

6 EDUCATION AND TRAINING REQUIREMENTS

6.1 All relevant staff must have read and understood this policy and the procedures therein. Risks associated with the storage, prescribing, preparation and administration of potassium chloride concentrate should be highlighted in patient safety training for all staff involved in the medication process.

6.2 Registered nurses administering Potassium must have completed the UHL IV study day and been assessed as competent and possess a UHL IV certificate. Training registered on HELM.

6.3 In addition to 6.2 nursing staff on adult critical care must have read the Protocol for the checking of IV drug administration within adult intensive care units (ICU)

6.4 Registered nurses required to administer or act as the independent checker for concentrated potassium solutions or high strength infusion must:

- Have received relevant training in reference to fluid management and renal failure.
- Have an awareness of the side-effects and contra-indications of giving IV potassium chloride.
- Have an understanding to when a potassium chloride infusion may be required and associated risks.
- Possess knowledge of acceptable time frame for monitoring serum potassium levels.

7 PROCESS FOR MONITORING COMPLIANCE

The following table lists the monitoring arrangements for this policy:

Element to be monitored	Lead	Tool	Frequency	Reporting arrangements
Datix medication incidents involving injectable potassium	Medicines safety officer	Datix incident reporting tool	Monthly	Medicines Optimisation Committee
Storage of potassium chloride High strength	Medicines safety officer	Leicester medicines code storage audit	annual	Medicines Optimisation Committee & CMG Q&S

8 EQUALITY IMPACT ASSESSMENT

8.1 The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.

8.2 As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

9 SUPPORTING REFERENCES, EVIDENCE BASE AND RELATED POLICIES

Leicestershire medicines code

Policy and Procedure for the preparation and administration of Intravenous medicines (B25/2010)

Policy and procedure for the management of controlled drugs on wards, departments and theatres B16/2009

Protocol for the checking of IV drug administration within adult intensive care units (ICU) (C18/2017)

Fluid Electrolyte Management UHL Childrens Medical Guideline (C6/2015)

Pharmacy Purchasing for Safety Policy C30/2017

Injectable medicines guide (Medusa) – see INSITE.

National Patient Safety Agency alert 23rd July 2002

10 PROCESS FOR VERSION CONTROL, DOCUMENT ARCHIVING AND REVIEW

10.1 The updated version of the Policy will then be uploaded and available through INsite Documents and the Trust's externally-accessible Freedom of Information publication scheme. It will be archived through the Trusts PAGL system.

10.2 This Policy will be reviewed every three years or sooner in response to clinical or risk issues.

Product	Potassium Content	Pack Volume
'Formulary' ready diluted potassium infusions		
Potassium Chloride 0.15% Sodium Chloride 0.9%	10mmol in 500ml	500ml
Potassium chloride 0.15% Sodium Chloride. 0.18% Glucose 4%	10mmol in 500ml	500ml
Potassium Chloirde 0.15% Sodium Chloride 0.45% Glucose 5%	10mmol in 500ml	500ml
Potassium Chloride 0.3% Sodium Chloride 0.9%	20mmol in 500ml	500ml
Potassium Chloride 0.3% Glucose 5%	20mmol in 500ml	500ml
Potassium chloride 0.3% Sodium Chloride. 0.18% Glucose 4%	20mmol in 500ml	500ml
Potassium chloride. 0.3% Sodium Chloride. 0.45% Glucose 5%	20mmol in 500ml	500ml
Potassium Chloride 0.3% Glucose 10%	20mmol in 500ml	500ml
Potassium Chloride 0.15% Sodium Chloride 0.9%	20mmol/L	1L
Potassium chloride. 0.15% Sodium Chloride 0.18% Glucose 4%	20mmol/L	1L
Potassium Chloride 0.15% Glucose 5%	20mmol/L	1L
Potassium chloride. 0.3% Sodium Chloride. 0.18% Glucose 4%	40mmol/L	1L
Potassium Chloride 0.3% Sodium Chloride 0.9%	40mmol/L	1L
Potassium Chloride 0.3% Glucose 5%	40mmol/L	1L
For Administration via a Central Line or large peripheral vein with cardiac monitoring.		
Potassium Chloride 0.6% Glucose 5%	40mmol/500 ml (80mmol/L)	500ml
Potassium Chloride 0.45% Sodium Chloride 0.9%	60mmol/L	1L
Potassium Chloride 0.6% Sodium Chloride 0.9%	80mmol/L	1L and 500ml bags
High Strength Potassium infusion only available in designated areas		
Potassium Chloride 3% Sodium Chloride 0.9%	40mmol/100 ml*	100ml*

* This infusion must be ordered, stored and recorded as a controlled drug

Potassium preparation	ITAPS	RRCV	ESM	Womens & Children	CHUGGs
Potassium Chloride ampoules 15% 20mmol in 10ml (10ml)				Paediatric Intensive care Units (PICU), Neonatal units (NNU) Antenatal Assessment Area (AAA)	
Potassium acid phosphate 13.6% 1mmol in 1ml (10ml)				PICU NNU ward 27	
Potassium prefilled syringe 50mmol in 50ml	GH Adult intensive care unit (ITU) and ITU ECMO LGH ITU LRI ITU				
Potassium prefilled syringe 10mmol in 20ml	Theatre recovery – all sites GH Catheter labs			PICU	
Potassium Chloride 3% in Sodium Chloride 0.9% containing 40mmol potassium in 100ml	LRI COD + LRI COD MAJAX	CCU	ED RESUS		LRI ward 41 and Bone marrow Transplant Unit (BMTU)
Sterile Concentrate of Cardioplegia 5.96% 15.98mmol Potassium in 20ml	GH Cardiac Theatres				

Concentrated ampoules / high strength solutions of potassium are not kept in any other CMGs

1. Introduction

Hypokalaemia is defined as a serum potassium concentration ≤ 3.5 mmol/L

The cause is most commonly increased excretion from diuretics or other medicines or gastrointestinal loss. Reduced intake or intracellular shift are relatively uncommon.
The goal of therapy is to

- prevent or treat- life threatening complications (arrhythmias, paralysis, rhabdomyolysis and diaphragmatic weakness)
- replace the potassium deficit
- diagnose and correct the underlying cause

The urgency depends on the severity of the hypokalaemia and the rate of decline in serum potassium concentration. The risk of arrhythmias is greatest with older patients, patients with heart disease and those on digoxin or antiarrhythmic drugs.

Cautions:

- This guideline assumes that the patient has normal renal function. Serum potassium may rise very quickly in patients with renal impairment. Please contact the renal team for specialist advice if the patient is on dialysis or severe renal impairment.
- For specialist treatment in areas eg intensive cares refer to local guidance.

2. Guideline

2.1 Signs and symptoms of hypokalaemia :

- Mild to moderate hypokalaemia may be asymptomatic
- Weakness
- Constipation
- Leg cramps
- Respiratory difficulties
- ECG changes
- Cardiac arrhythmias especially in patients who are ischaemic, on digoxin or in heart failure
- Rhabdomyolysis (severe hypokalaemia)
- Ascending paralysis (severe hypokalaemia)

2.2 Causes :

a) Increased potassium loss
   - Drugs (see table below)
   - GI losses: diarrhoea, vomiting
   - Renal causes, dialysis
   - Endocrine disorders : hyperaldosteronism (Conn's syndrome), Cushing's syndrome

b) Trans – cellular shift :
   - Insulin/ glucose therapy
   - Metabolic alkalosis
   - Drugs (see box below)

c) Decreased potassium intake

d) Magnesium depletion (associated with increased renal potassium loss)

General Principles for treatment :

- Always establish and treat the underlying causes of hypokalaemia. Do not just treat the biochemical imbalance.
- Maximum daily replacement should not generally exceed 200-300mmol potassium
- Check magnesium serum levels particularly when loss is associated with diarrhoea or diuretic therapy. Hypokalaemia may be associated with or caused by magnesium depletion and it is often difficult to replace potassium without sufficient magnesium levels. If magnesium levels are low treat as per the UHL guidelines for the treatment of hypomagnesaemia (C10/2002)
- Monitor patient's fluid balance
- Patients with primary aldosteronism may present with hypokalaemia due to renal potassium wasting. Spironolactone or eplerenone (potassium sparing diuretics are the treatment of choice)
- Monitor Potassium carefully when prescribing potassium with ACE inhibitors and potassium sparing diuretics

2.3 Mild / moderate hypokalaemia: K^+ >3.0 to 3.4mmol/L (see table for treatment)

- The majority of mild /moderate hypokalaemia is asymptomatic
- Exceptions include patients:
  - with heart disease particularly if they are taking digoxin, other antiarrhythmic drugs
  - undergoing cardiac surgery
  - patients with cirrhosis in whom hypokalaemia can increase ammonia generation and promote the development of hepatic encephalopathy.
  - For patients who are symptomatic then consider the higher oral dose

Potassium Chloride (Sando-K®) effervescent tablets
3 tablets TDS after food

IV therapy is an alternative if oral is not tolerated as per the table for symptomatic

2.4 Uncontrolled diabetes:

In diabetic ketoacidosis and insulin deficiency potassium is likely to move out of cells and may result in a normal or elevated potassium when there may be a underlying potassium deficit from another cause. As insulin therapy and fluid replacement is given the serum potassium will lower to the actual deficit and potassium supplementation should then be commenced. (see Guideline for management of Diabetic Ketoacidosis (DKA) in adults B66/2011)

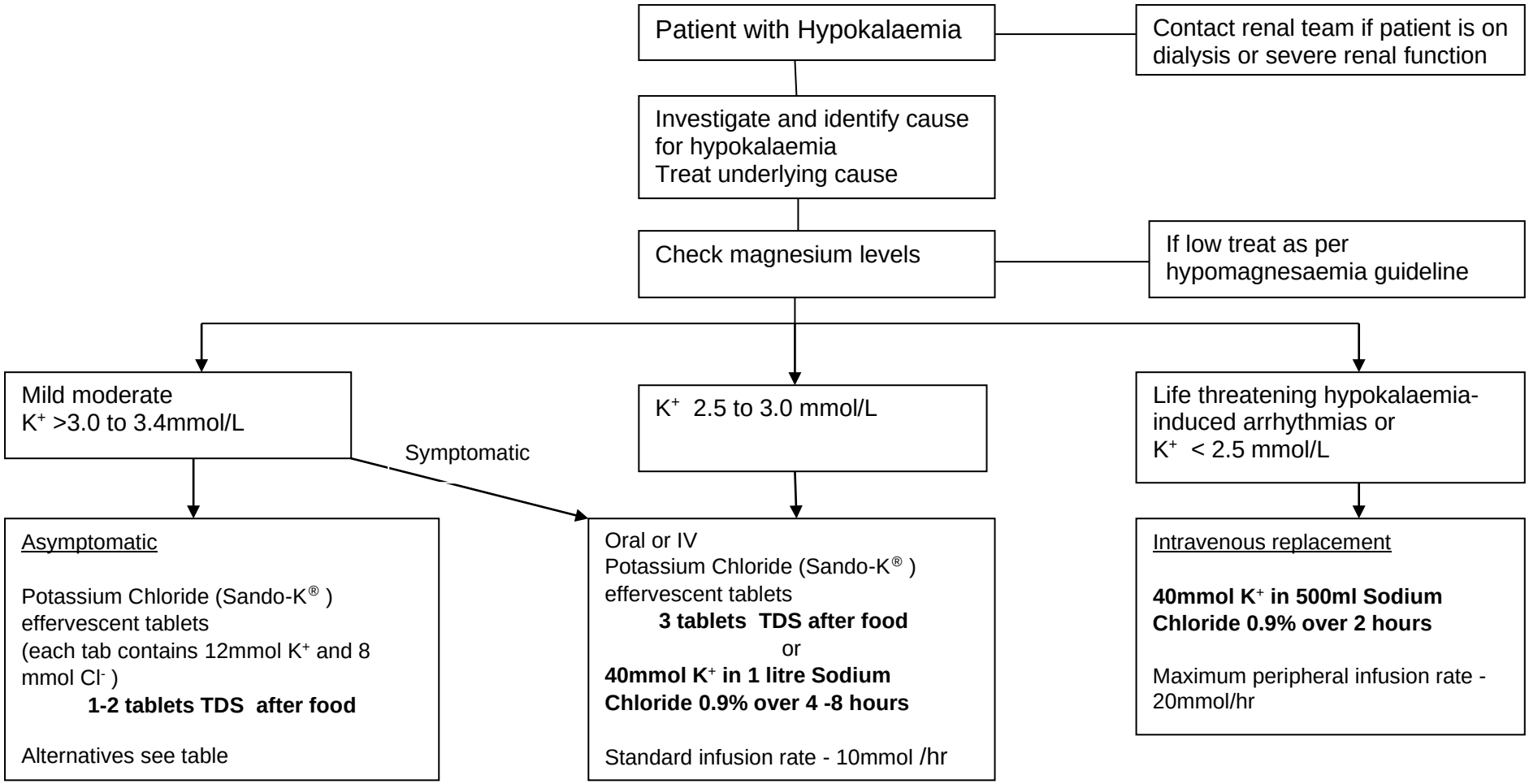
If the patient presents with a marked potassium loss and is hypokalaemic then potassium must be replaced aggressively **40mmol K^+ in 500ml Sodium Chloride 0.9% over 2 hours** prior to insulin treatment until the serum potassium is above 3.0mmol to avoid possible complications such as cardiac arrhythmias. Hourly monitoring is required.

2.5 Drugs which can cause or increase risks associated with Hypokalaemia include the following :

- loop or thiazide diuretics
- mineralocorticoids
- insulin
- digoxin
- theophylline, aminophylline, caffeine
- high doses of beta-agonists (salbutamol and formoterol)
- verapamil, chloroquine and quetiapine in overdose
- laxatives
- drugs primarily causing hypomagnesaemia:
  - aminoglycosides, Cisplatin, amphotericin B

Serum Potassium	Treatment	Comments
Mild to moderate K^+ >3.0 to 3.4mmol/L	<u>Oral replacement</u> Potassium Chloride (Sando-K®) effervescent tablets (each tab contains 12mmol K^+ and 8 mmol Cl^-) **1-2 tablets TDS after food** Alternatives: Potassium Chloride (Slow-K®) 600mg tablets (each tab contains 8mmol K^+ and Cl^-) **1-2 tablets TDS with food** Potassium Chloride Syrup (Kay-Cee-L) 1mmol K^+ and Cl^- per ml **10-20ml TDS**	• monitor K^+ daily and adjust treatment accordingly • Continue until potassium in normal range • Slow K may cause local ulceration. Should be taken while sitting or standing with fluids during meals. • Consider IV if oral is not tolerated. Use potassium bags with sodium chloride 0.9% initially rather than glucose. If symptomatic consider the higher oral dose seen in the row below.
Symptomatic mild / moderate Or K^+ 2.5 to 3.0 mmol/L	Oral or IV treatment: <u>Oral replacement</u>: Potassium Chloride (Sando-K®) effervescent tablets **3 tablets TDS after food** <u>Intravenous replacement</u> **40mmol K^+ in 1 litre Sodium Chloride 0.9% over 4 -8 hours** Standard infusion rate - 10mmol /hr	• K^+ depletion can be accomplished using oral therapy • ready mixed Bags must always be used if IV • Check Potassium every 4 hours to ascertain response to therapy for oral or IV • repeat infusion if required. • Reduce oral dose when serum concentrations are persistently over 3.0mmol/L • Glucose containing solutions may reduce serum potassium concentrations, so glucose free solutions may be more suitable for initial treatment.
Life threatening hypokalaemia-induced arrhythmias or K^+ < 2.5 mmol/L	<u>Intravenous replacement</u> **40mmol K^+ in 500ml Sodium Chloride 0.9% over 2 hours** Maximum peripheral infusion rate - 20mmol/hr	• ready mixed Bags must always be used • severe phlebitis may occur with concentrated solutions • potassium infusions– use largest suitable peripheral vein or consider giving via a central line • Check Potassium every 4 hours • repeat infusion after 4 hours if potassium is still low. • **CARDIAC MONITORING IS MANDATORY FOR RAPID TREATMENT** Note: In ITUs potassium may be administered centrally in a smaller volume.

NOTE : K^+ and Cl^- have been used as abbreviations for potassium and chlorine in the above table but must not be used when prescribing.



Monitor response to potassium initially every 4 hours. Potassium levels may rise initially and then fall as potassium uptake into cells increases.

Repeat infusions if giving IV therapy or consider changing to oral therapy if potassium has increased.