Guideline for the Management of Acute Hyperkalaemia in Adults	
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Directorate & Speciality	Diagnostics and Clinical Support
Date of submission	April 2013
Date on which guideline must be reviewed (this should be one to three years)	April 2015
Explicit definition of patient group to which it applies (e.g. inclusion and exclusion criteria, diagnosis)	Applies to: All adult inpatients and outpatients referred with incidental hyperkalaemia Excludes: Diabetic ketoacidosis (DKA), Paediatrics
Abstract	This guideline describes the management of Acute Hyperkalaemia in all adult inpatients and outpatients
Key Words	Potassium, Hyperkalaemia, Hyperkalemia
Changes from previous guideline	Re-defined severity of hyperkalaemia according to UK Renal Association Clinical Practice Guidelines Added a timescale for how long to monitor BMs for after administration of the Actrapid and Glucose 50% infusion No justification of routine IV bicarbonate use unless discussed with Renal SpR or Consultant or Critical Care
Approval	Drugs & Therapeutics Committee
Target audience	NUH intranet, Nursing, pharmacy & medical staff
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This guideline has been registered with the trust. However, clinical guidelines are guidelines only. The interpretation and application of clinical guidelines will remain the responsibility of the individual clinician. If in doubt contact a senior colleague or expert. Caution is advised when using guidelines after the review date.

Summary – Management of Acute Hyperkalaemia

This guideline covers the management of hyperkalaemia in inpatients and in outpatients referred with incidental hyperkalaemia from their GP or the Outpatient Department.

This guideline does **NOT** apply to the management of hyperkalaemia in Diabetic ketoacidosis (follow DKA guideline).

For all **inpatients** request an ECG and see flowchart and main guideline.

For all **outpatients** with K^+ > 6.0 mmol/L (K^+ >6.5 mmol/L in **renal** patients) arrange for the patient to attend the admissions unit for an ECG and repeat potassium sample:

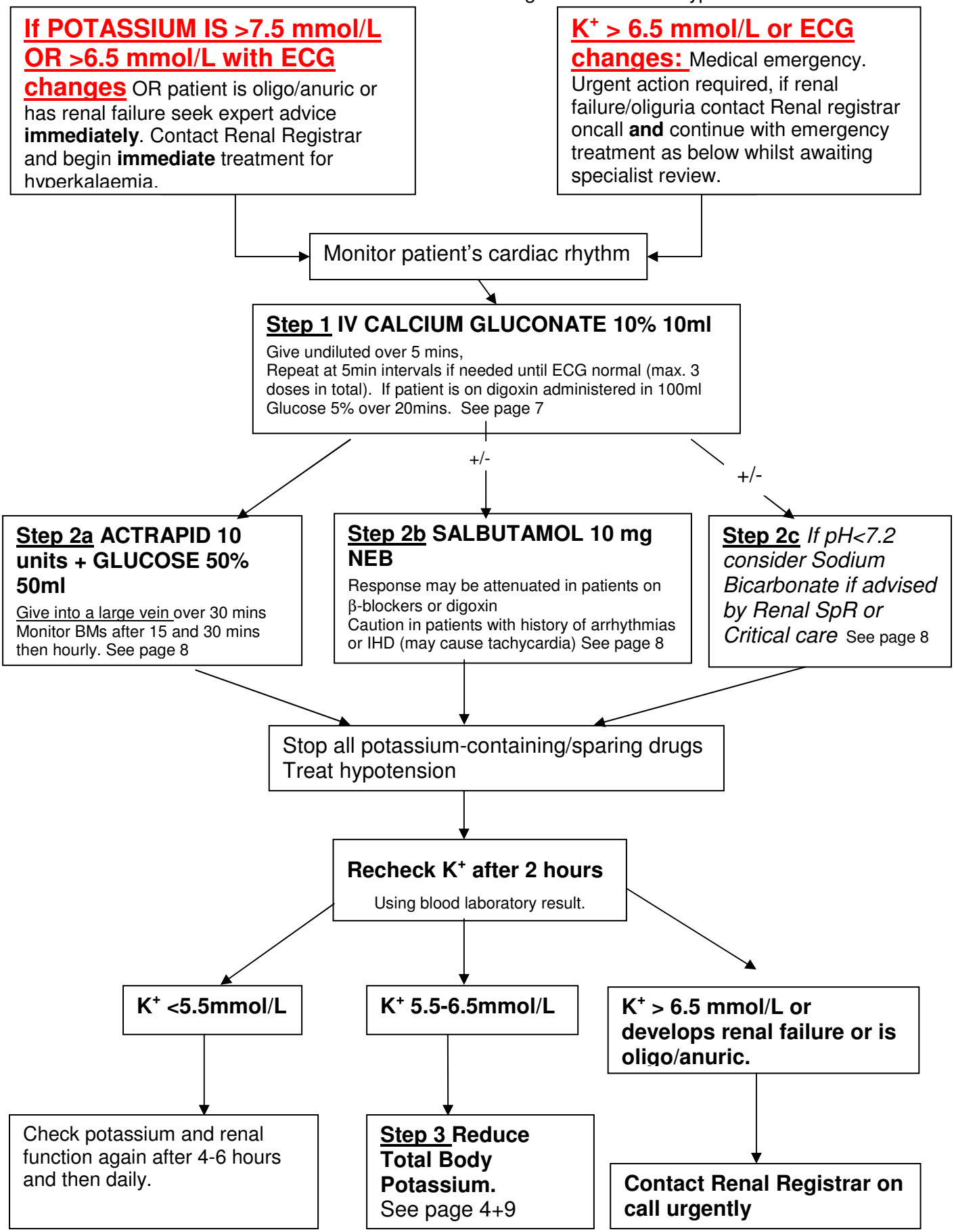
⇨ Send blood sample for repeat serum potassium urgently. For patients with "fragile" red cells, chronic lymphocytic leukaemia, thrombocytosis, and vasculitis request Whole Blood Potassium (in a Lithium-Heparin tube).

If significant hyperkalaemia or ECG changes present do not delay treatment while awaiting the repeat result/specialist review by Renal registrar. ECG changes observed in hyperkalaemia are tall peaked T waves, flattening or loss of p waves, broadening of QRS complexes, and bradycardia.

⇨ **Repeat K^+ < 6.0 mmol/L** and renal function stable - no urgent action required. Arrange dietary modification and medication review; admission to hospital is not required.

⇨ **Repeat K^+ = 6.0 - 6.5 mmol/L** follow the guideline and consider discharge if appropriate.

⇨ **Repeat K^+ > 6.5 mmol/L** follow the guideline


If POTASSIUM IS >7.5 mmol/L OR >6.5 mmol/L with ECG changes OR patient is oligo/anuric or has renal failure seek expert advice immediately. Contact Renal Registrar and begin immediate treatment for hyperkalaemia.
K+ > 6.5 mmol/L or ECG changes: Medical emergency. Urgent action required, if renal failure/oliguria contact Renal registrar oncall and continue with emergency treatment as below whilst awaiting specialist review.
Monitor patient's cardiac rhythm
Step 1 IV CALCIUM GLUCONATE 10% 10ml
Give undiluted over 5 mins,
Repeat at 5min intervals if needed until ECG normal (max. 3 doses in total). If patient is on digoxin administered in 100ml Glucose 5% over 20mins. See page 7
+/-
+/-
Step 2a ACTRAPID 10 units + GLUCOSE 50% 50ml
Give into a large vein over 30 mins
Monitor BMs after 15 and 30 mins then hourly. See page 8
Step 2b SALBUTAMOL 10 mg NEB
Response may be attenuated in patients on β-blockers or digoxin
Caution in patients with history of arrhythmias or IHD (may cause tachycardia) See page 8
Step 2c If pH<7.2 consider Sodium Bicarbonate if advised by Renal SpR or Critical care See page 8
Stop all potassium-containing/sparing drugs
Treat hypotension
Recheck K+ after 2 hours
Using blood laboratory result.
K+ <5.5mmol/L
K+ 5.5-6.5mmol/L
K+ > 6.5 mmol/L or develops renal failure or is oligo/anuric.
Check potassium and renal function again after 4-6 hours and then daily.
Step 3 Reduce Total Body Potassium.
See page 4+9
Contact Renal Registrar on call urgently

K^+ 6.0 - 6.5 mmol/L with no ECG changes

- ☐ **Exclude pseudohyperkalaemia**
- ☐ **Stop all potassium-containing/sparing drugs**
- ☐ **Low potassium diet**
- ☐ **Ensure adequate hydration and monitor urine output**
- ☐ **Treat hypotension**
- ☐ **Monitor renal function**

See page 6 for clinical assessment and investigations

Consider step 2 onwards in addition to below

Step 3 REDUCE TOTAL BODY POTASSIUM (See page 9)

3a) REDUCE POTASSIUM INTAKE
Stop all potassium containing/sparing drugs
Consider low potassium diet (See Appendix 3)

3b) PROMOTE URINARY POTASSIUM LOSS
Use of appropriate fluids or diuretics

3c) REMOVE EXCESS POTASSIUM
Calcium Resonium 15g PO TDS, if oral route not available, calcium resonium enemas are available (See Appendix 2)
(This may not be necessary if the obvious cause for hyperkalaemia has been identified and corrected)

Recheck K^+ after 4-6 hours then daily

Consider stopping calcium resonium when K^+ <6.0mmol/L.
Stop treatment when $K^+ \leq 5.5$ mmol/L.
Continue with other supportive measures

3d) DIALYSIS
If patient does not respond to above measures, contact Renal Registrar on call urgently to discuss further management

GUIDELINE FOR THE MANAGEMENT OF ACUTE HYPERKALAEMIA

This guideline covers the management of hyperkalaemia. It does **NOT** apply to the management of hyperkalaemia in diabetic ketoacidosis (follow DKA guideline)

If significant hyperkalaemia or ECG changes present, this constitutes a medical emergency. Do not delay treatment whilst awaiting the repeat result/specialist review by Renal registrar. ECG changes observed in hyperkalaemia are tall peaked T waves, flattening or loss of p waves, broadening of QRS complexes, and bradycardia.

⇨ Repeat K^+ < 6.0 mmol/L and renal function stable - no urgent action required. Arrange dietary modification and medication review; admission to hospital is not required.

⇨ Repeat K^+ = 6.0 - 6.5 mmol/L follow the guideline and consider discharge if appropriate.

⇨ Repeat K^+ > 6.5 mmol/L follow the guideline.

Definition

Hyperkalaemia is classified as a raised serum potassium level

- Mild: K^+ = 5.5-5.9mmol/L
- Moderate: K^+ = 6-6.4mmol/L
- Severe: K^+ ≥ 6.5mmol/L or if ECG changes or symptoms present

Symptoms and Signs

- Arrhythmias
- Muscle weakness, constipation
- ECG changes (peaked T waves, loss of P waves, widening of QRS complexes, PR prolongation, asystole)

Causes of Hyperkalaemia

- Pseudohyperkalaemia
  - Test tube haemolysis - NEVER refrigerate samples and ensure samples arrive at the laboratory within 5 hours
  - EDTA contamination (from FBC sample tube)
  - Prolonged tourniquet time
  - Marked leucocytosis and thrombocytosis (measure **Lithium Heparin whole blood potassium** not serum concentration in these disease states)
  - Sample taken from drip arm
- Acute kidney injury
- Chronic kidney disease
- Drugs (potassium supplements, potassium-sparing diuretics such as amiloride, aldosterone antagonists such as spironolactone, ACE inhibitors, angiotensin II antagonists, NSAIDs, heparin, β-blockers, digoxin poisoning)
- Acidosis, including diabetic ketoacidosis (NB this guideline does **not** apply to the management of hyperkalaemia in DKA: see below and separate DKA Guideline).
- Mineralocorticoid deficiency (e.g. Addison's)
- Endogenous (tumour-lysis syndrome, rhabdomyolysis, trauma, burns)

Please note that this list is not comprehensive and that other causes may need to be considered.

Clinical Assessment

- Urine output – very important. If oliguric, medical treatment much less likely to work.
- Review potassium intake e.g. IV fluids, potassium supplements, diet
- Review drugs (ACE inhibitors, Angiotensin II Antagonists and potassium sparing diuretics)
- Review history for possible causes of renal disease or major tissue destruction
- Review recent biochemistry results, in particular renal function and recent potassium levels
- Fluid status – signs of dehydration or fluid overload
- Potassium levels may be assessed on an arterial or venous blood sample using a point of care blood gas analyser in emergencies. This must be followed up with a formal laboratory measurement.

Investigations

- 12-lead ECG
- U&Es, venous bicarbonate, glucose, FBC
- If unwell consider arterial blood gases

Treatment of Hyperkalaemia

- ⇨ **Exclude pseudohyperkalaemia.**
- ⇨ **Stop all potassium supplements (IV and oral).**
- ⇨ **Review patient's medication for possible contributors to hyperkalaemia and or acute renal failure.**
- ⇨ **Reduce dietary K^+ intake**
- ⇨ **Ensure adequate hydration and urine output**
- ⇨ **If potassium > 6.5mmol/l or ECG changes monitor patient's cardiac rhythm until it is stable and potassium level is in range**

Diabetic Ketoacidosis (DKA)

Hyperkalaemia often occurs at presentation of diabetic ketoacidosis (DKA). In this situation, the patient is dehydrated and total body potassium is low. Hyperkalaemia resolves extremely rapidly and so the following guideline does not apply to the management of hyperkalaemia in DKA (see separate DKA Guideline).

⇨ After the above, there are **three steps** in managing hyperkalaemia.

For details of mode of actions of the interventions refer to Appendix 1.

If serum K^+<6.5 mmol/L and there are no ECG changes/symptoms of hyperkalaemia then omit Step 1 and consider step 2 (reduce cell membrane excitability, shift potassium intracellularly).

Step 1. Reduce cardiac cell membrane excitability

CALCIUM GLUCONATE 10% 10 mL IV over 5 mins

- This does **not** lower the serum potassium but protects the cardiac membrane
- ECG changes should improve within 1 to 3 minutes and its effect lasts for approximately 30 minutes.
- If necessary doses may be repeated after 5 minutes up to maximum of 3 doses.
- If the patient is taking digoxin, the calcium gluconate should be given slowly (mixed with 100mls 5% dextrose and given over 20 minutes) as rapid calcium administration may precipitate myocardial digoxin toxicity.
- Never given at the same time as sodium bicarbonate via the same access site due to the risk of precipitation

Step 2. Shift potassium from extracellular to intracellular space

Shifting potassium intracellularly is a useful holding measure in life threatening hyperkalaemia. However, it does **not** reduce total body potassium, and after two to six hours, there is an efflux of potassium back out into the extracellular space resulting in serum levels as high or sometimes even higher than at the outset. Therefore, any of the steps in section 2 must be combined with those in section 3, and serum potassium must be regularly rechecked.

IT IS NOT SATISFACTORY TO PERFORM ANY OF THE MANAGEMENT STEPS IN STEP 2 WITHOUT REGULAR, ONGOING ASSESMENTS OF THE PATIENT.

If the patient has renal failure (particularly if they are oligo/anuric) then urgent dialysis may be required. Contact the Renal Registrar on call urgently. If haemodialysis is planned for within 15-30 minutes then treatments to move potassium into cells are unlikely to be helpful and may make potassium removal on dialysis more difficult.

2a) <u>INSULIN ACTRAPID</u> 10 units in 50 mL of Glucose 50% IV over 30 minutes via volumetric pump

- Always give into a large vein as irritant
- Reduces serum K^+ by 0.65 – 1.0 mmol/L
- Monitor blood glucose after 15mins, 30mins and then hourly for up to 6 hours as there is a risk of late hypoglycaemia

2b) <u>SALBUTAMOL</u> 10mg nebulised

- Reduces serum K^+ by 0.62-0.8 mmol/L **but response has been shown to be inconsistent – this step is optional and must not used as single agent.**
- Additive to insulin/glucose
- Caution in patients with ischaemic heart disease and history of cardiac arrhythmias (avoid/use lower dose)
- Response attenuated in patients on β-blockers and digoxin

2c) <u>SODIUM BICARBONATE</u> 1.4 % 500 mL IV over 2 hours – ONLY CONSIDER IF pH < 7.2. (Seek advice from pharmacy regarding availability of alternative preparations if there is a supply problem with 1.4% bicarbonate)

- **The use of sodium bicarbonate is controversial in patients with acidosis. There is insufficient evidence to justify routine use and use of sodium bicarbonate is associated with significant risk of sodium and fluid overload (e.g. pulmonary oedema). It should therefore only be used after discussion with Renal SpR or Consultant or Critical Care**
- Risk of tetany in patients with chronic renal failure and underlying hypocalcaemia
- Never give at the same time as IV calcium via the same access site due to the risk of precipitation

After **any** of the above steps:

- **Recheck potassium 2 hours after treatment.**
- **If K^+ remains > 6.5mmol/L or ECG changes persist contact Renal SpR on call urgently.**
- **If potassium has improved but the patient is oligo/anuric or developing renal failure contact the Renal Registrar on call urgently as the potassium will almost certainly rebound.**

Step 3. Reduce total body potassium

3a) REDUCE POTASSIUM INTAKE

- Low potassium diet (consider dietetic review and order appropriate diet, remember food from home). See Appendix 3
- Avoid drugs which raise potassium

3b) PROMOTE URINARY POTASSIUM LOSS

- Monitor fluid balance and encourage good urine output by ensuring adequate hydration with oral or IV fluids. Normal Saline 0.9% is preferable so long as the patient is not significantly overloaded
- Treat hypotension – remember to review the drug chart e.g. antihypertensives
- If well hydrated consider starting or increasing the dose of a loop diuretic

3c) REMOVE EXCESS POTASSIUM

- Calcium Resonium has a slow onset of action (at least 2-6 hours) – interim measures as above required
- Removes K^+ from gut by ion exchange thus lowers total potassium load
- Each gram of Calcium Resonium® removes approx. 1 mmol/L potassium from the gut
- **Caution:** contraindicated in patients with pre-existing hypercalcaemia
- May cause constipation – co-prescribe lactulose 10 mL BD
- May not be necessary if the obvious cause of hyperkalaemia has been identified and corrected.
- Monitor U&Es daily and consider stopping when $K^+ < 6.0$ mmol/L. Once $K^+ < 5.5$ mmol/L discontinue treatment.
- If oral route not available consider Calcium Resonium® enema 30g per rectum (PR) daily, however this is poorly tolerated by patients (see Appendix 2 for administration guide)

3d) DIALYSIS

- If the patient does not respond to the above measures dialysis will be required
- DIALYSIS IS LIKELY TO BE NEEDED IF POTASSIUM VERY HIGH (>7.5 mmol/L), PATIENT IS OLIGO/ANURIC, PATIENT IS ALREADY ON LONGTERM DIALYSIS OR HAS ADVANCED CKD.
- In these situations contact the Renal Registrar on call urgently to discuss management.

References:

1. Ahee P, Crowe AV. The management of hyperkalaemia in the emergency department. *J Accid Emerg Med* 2000; **17**: 188-191
2. Clinical Resource Efficiency Support Team, Northern Ireland. CREST – Guidelines for the treatment of hyperkalaemia in adults; January 2006; accessed at www.crestni.org.uk
3. Weisberg LS. Management of severe hyperkalemia. *Crit Care Med* 2008; **36:12;** 3246-3251
4. Burgess C. Clinical Management Guideline for Patients with Hyperkalaemia, Kings College Hospital NHS Foundation Trust. Version 1 September 2008
5. Alfonzo A. et al. Treatment of Acute Hyperkalaemia in Adults. The Renal Association. July 2012
6. Smyth J [Ed]. The NEWT Guidelines Online. Wrexham Maelor Hospitals Pharmacy Department. Accessed on 04/07/2013

Appendix 1 - Treatment Notes

Treatment	Mechanism of Action	Time to Onset of Action	Duration of Action	Achievable reduction of serum K^+
Calcium Resonium®	Ion-exchange resin that exchanges sodium for potassium as it passes through intestine	2-6 hours or longer	4-6 hours	unknown
Calcium gluconate	Antagonises cardiac membrane excitability	Immediate	5 mins	N/A
Insulin Actrapid with Glucose	Increased intracellular uptake of K^+ via Na-K ATP pump	Within 15 mins	60 mins	0.65-1mmol/L
Nebulised Salbutamol	Increased intracellular uptake of K^+ via Na-K ATP pump; response attenuated by patients on β blockers or digoxin	Variable effect, acts within 30 mins, maximum effect after up to 90 mins	1-3 hours	0.62-0.98mmol/L
Sodium Bicarbonate	Corrects acidosis and thus promotes intracellular uptake of K^+	After 60 mins, effect variable	unknown	unknown

Appendix 2 - Guide for the Administration of Rectal Calcium Resonium

Indication: Hyperkalaemia associated with anuria or oliguria where administration orally is not possible

Caution: Contraindicated in patients with pre-existing hypercalcaemia

Often there is difficulty ensuring the enema is retained for the necessary 9 hours and there is the risk of faecal impaction and bowel perforation occurring when irrigating the colon to remove the resin.

Dose: Calcium Resonium enema 30 g rectally to be retained for 9 hours and repeated daily as necessary

You will need:
Phosphate enema x 1
Calcium Resonium enema x 1
Aquagel® sachets x 1-2
Rectal catheter x 1
50 ml bladder syringe x 1
50-100 ml water, warmed to body temperature

1. Ensure rectum is empty by administering a phosphate enema
2. Place the patient in left lateral position
3. Lubricate the nozzle of a rectal catheter with some Aquagel® and introduce the tube into the rectum to a depth of around 10-12.5 cm
4. Remove the plunger from the rectal syringe and attach the syringe to the rectal catheter
5. Shake the jar containing the Calcium Resonium® well
6. Pour the Calcium Resonium® enema into the syringe and allow it to flow into the patient by gravity
7. Rinse the jar with 50-100 ml of water warmed to body temperature and administer via the same bladder syringe by gravity
8. Where possible the patient should then remain supine with the foot of the bed raised or with pillows placed to elevate the hips as the enema should be retained for 9 hours or as long as possible
9. If the patient has not already expelled the Calcium Resonium® enema after 9 hours, the colon should be irrigated with tap water warmed to body temperature to remove the remaining resin

Appendix 3 – Low Potassium Diet

Every inpatient diagnosed with acute kidney injury (AKI) who requires a low potassium diet should be referred to a dietitian by contacting the department of dietetic and nutrition:

- City Campus: extension 55235
- QMC Campus: extension 62040

A dietitian will assess each patient individually and will provide appropriate dietetic advice based on the patients current potassium intake and clinical conditions.
Dietitians are trained to advise on a low potassium diet as well as ensuring that the patients diet is well balanced. Many inpatients with AKI may require a low potassium diet only temporarily. Following a low potassium diet if not needed will inevitably lead to water soluble vitamin and micronutrient deficiency.
This appendix should be used during weekend or bank holiday only. Inpatients should still be referred to the department of Dietetics and Nutrition as the dietitians will provide appropriate dietetic advice and follow up.
The following only provides an initial basic guide for inpatient with AKI who need to follow a low potassium diet:

1) Inform your dietitian by ringing the Department of Dietetics and Nutrition

2) Liaise with the hospital kitchen and arrange a low potassium/renal diet by ringing :
    - City Campus: extension 59099
    - QMC Campus: extension 66626/59099

3) Inform the patient about the following:

Avoid the following drinks	**Avoid the following food**
Fruit Juice Coffee Malted drinks Hot chocolate	Tomato soup Mushroom soup Jacket potatoes, Chips, Crisp Nuts Chocolate Oranges Banana Grapes

Your ward dietitian will provide individualised dietetic advice with appropriate food options that will be suitable for your patient.