Birmingham Women's and Children's NHS Foundation Trust

Hyperkalaemia Management Guideline for Neonates, Children and Adults for Birmingham Women and Children's NHS Foundation Trust

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Algorithm for the Treatment of Hyperkalaemia

Assess ABCDE

Perform 12 lead ECG or monitor continuous ECG
Repeat K^+ in laboratory
Stop all K^+ containing IV fluids/drugs affecting K^+

ECG Changes: Peaked/tented T waves; wide QRS; long PR interval; diphasic QRS ('sine wave'); flat/loss of P waves; VF/Asystole

Assess

Patient Age	SEVERE ECG changes / symptomatic	MODERATE No ECG changes / asymptomatic	MILD No ECG changes / asymptomatic
Neonate	$K^+ \geq$ 7.6mmol/L	K^+ 7.1-7.5mmol/L	K^+ 6.5-7mmol/L
> 1 month to < 14yrs	$K^+ \geq$ 7.1mmol/L	K^+ 6.1-7mmol/L	K^+ 5.5-6mmol/L
≥ 14yrs	$K^+ \geq$ 7.1mmol/L	K^+ 6.1-7mmol/L	K^+ 5.5-6mmol/L
	⇒ STEP 1+2+3	**⇒ STEP 2+3**	**⇒ STEP 3**

STEP 1

STEP 1: Most urgent! *Always* start with step 1 if severe hyperkalaemia, then continue to steps 2 and 3

Patient Age	**Give IV calcium** (stabilises the cardiac membrane to prevent arrhythmias) Can be repeated- see full guideline
Neonate	Calcium Gluconate 10% 0.5ml/kg over 10 minutes Give centrally whenever possible, via most distal lumen available If no central access available, dilute x 5 volume with Sodium Chloride 0.9%
>1 month to <14yrs	Calcium Gluconate 10% 0.5ml/kg over 10 minutes (max 20ml) diluted to 50ml with Sodium Chloride 0.9%
≥14yrs	Calcium Gluconate 10% 20ml over 10 minutes

STEP 2

STEP 2: Start with step 2 in cases of moderate hyperkalaemia, then continue to step 3

Patient Age	**Give Salbutamol** (moves K^+ into cells) Nebs can be rptd- see full guideline	**Give Insulin/Glucose** (moves K^+ into cells) Monitor blood glucose every 30 mins for 6 hours
Neonate	Give Nebulised Salbutamol as in Step 3 *or* IV Salbutamol 4 microgram/kg/dose over 5 minutes, diluted to 2ml with Sodium Chloride 0.9%	Add 0.1units/kg soluble insulin (actrapid) to 1g/kg of glucose over10 minutes. ***(see Monograph/Appendix C for preparation)***
>1 month to <14yrs		
≥14yrs		Add 10 units of soluble Insulin (actrapid) to 50ml Glucose 50% or 125ml glucose 20% .Give over 5-10 minutes.

STEP 3

STEP 3: Start with step 3 in cases of mild hyperkalaemia

Patient Age	**Nebulised Salbutamol** (moves K^+ into cells)	**IV Furosemide** (increases K^+ elimination)	**Calcium Resonium** (increases K^+ elimination)
Neonate	2.5mg	1mg/kg/dose over 5 mins	Rectally 125-250mg/kg/dose four times a day
>1 month to <14yrs	2.5mg for < 10kg 5mg for ≥ 10kg	1mg/kg/dose (max 20 mg) over 5 mins	Oral/rectally 125-250mg/kg/dose four times day
≥14yrs	10mg	20mg over 5 mins	Oral/rectally 15 grams four times a day

Monitor

Use the following table to record and assess response to treatment:

Monitor K^+/gluc until K^+ is: **< 6.5 in those ≤$^1/_{12}$** **< 5.5 in those >$^1/_{12}$**	**0min** Time: … : …	**15min** Time: … : …	**30min** Time: … : …	**45min** Time: … : …	**60min** Time: … : …	**90min** Time: … : …	**120min** Time: … : …	**4hours** Time: … : …	**6hours** Time: … : …
K^+ (mmol/L)									
Glucose (mmol/L)									

Consider Causes of Hyperkalaemia:

Renal failure
DKA
Adrenal insufficiency (e.g. Addison's disease, CAH)
Pseudohyperkalaemia (esp. from haemolysis)
Drugs (e.g. K supplements, ACE inhibitors, β-blockers, suxamethonium, trimethoprim, diuretics)
Cell lysis (tumour lysis syndrome, rhabdomyolysis, severe burns, trauma)

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1. Goals of Therapy and Progression of Cardiac Symptoms

1.1 Goals of therapy in chronological order:

1) Antagonise effect of potassium on excitable cell membranes, especially cardiac cells. (RED box therapy)
2) Redistribute extracellular potassium back into cells (YELLOW box therapy)
3) Enhance elimination of potassium from the body (GREEN box therapy)

1.2 Progression of cardiac symptoms in hyperkalaemia:

Increasing serum potassium depolarises the cell membrane, slows ventricular contraction and decreases action potential to produce the following ECG changes:

- Peaked or "tented" T waves
- Widening QRS complex
- Long PR interval
- Wide, bizarre, diphasic QRS complexes ("sine wave")
- Flattened or loss of P waves
- Ventricular fibrillation (VF)
- Asystole

The sensitivity of ECG to reveal increasing potassium levels can be low but increases in proportion to severity, therefore ECG changes may manifest first as VF. Therefore high potassium with no ECG changes must still be treated with urgency.

2. When to Treat Hyperkalaemia

Patient Age	Severe	Moderate	Mild
Neonate	$K^+ \geq$ 7.6mmol/L or ECG changes/symptomatic	K^+ 7.1-7.5mmol/L with no ECG changes/asymptomatic	K^+ 6.5-7mmol/L with no ECG changes/asymptomatic
Over 1 month to 14 years of age	$K^+ \geq$ 7.1mmol/L or ECG changes/symptomatic	K^+ 6.1-7mmol/L with no ECG changes/asymptomatic	K^+ 5.5-6mmol/L with no ECG changes/asymptomatic
Over 14 years and adults	$K^+ \geq$ 7.1mmol/L or ECG changes/ symptomatic	K^+ 6.1-7mmol/L with no ECG changes/asymptomatic	K^+ 5.5-6mmol/L with no ECG changes/asymptomatic

If **Severe** $\Rightarrow$ go to RED box/STEP 1 immediately followed by YELLOW/STEP 2 and then GREEN/ STEP 3

If **Moderate** $\Rightarrow$ go to YELLOW/STEP 2 and then GREEN/ STEP 3

If **Mild** $\Rightarrow$ go to GREEN/ STEP 3

2.1 Management of severe hyperkalaemia - RED/STEP 1

Start therapy here if the patient is unstable/symptomatic, the ECG is abnormal or the serum potassium is greater than or equal to 7.1mmol/L (over 1 month age) or 7.6mmol/L (neonates).

Below is the suggested order of treatment, but this may be varied according to what access is available. For example, if no intravenous (iv) access is available, initial treatment may begin with nebulised Salbutamol whilst iv access is gained.

If no cardiac monitoring, obtain a 12 lead ECG and arrange continuous ECG monitoring immediately. ***Do not let obtaining an ECG delay proceeding with treatment below.***
Stop all potassium containing medications or medications that can increase potassium.*
Repeat serum potassium to ensure true result within 15 minutes of high potassium result. If via blood gas analyser, also send lithium heparin sample to clinical chemistry urgently.
Repeat serum potassium every 15 minutes until serum potassium below 6.5mmol/L for neonate or below 5.5mmol/L for infant over 1 month.

**Contact parent team prior to withholding any doses of Tacrolimus or Ciclosporin*

STEP 1: Give CALCIUM to stabilise cardiac membrane	
Neonate	Calcium gluconate 10% 0.5ml/kg over 10 minutes Give centrally whenever possible, via most distal lumen available If no central access available, dilute x 5 volume with sodium chloride 0.9%
Over 1 month to 14 years	Calcium gluconate 10% 0.5ml/kg over 10 minutes (max 20ml) diluted to 50ml with sodium chloride 0.9%
Over 14 years/ adult	Calcium gluconate 10% 20ml over 10 minutes

If patient is taking digoxin or digoxin toxicity is suspected, extend the calcium infusion to run over 30 minutes

Calcium chloride may be used if there is central access available: 0.1mmol/kg/dose over 5 minutes

If ECG changes persist after 5 minutes, repeat calcium gluconate 10% administration to maximum of 3 times.

2.2 Management of Moderate Hyperkalaemia - YELLOW/STEP 2

Start therapy here if the patient is stable/asymptomatic or there are no ECG changes with potassium 6.1 - 7mmol/L (over 1 month age) or 7.1 - 7.5mmol/L (neonates).

If no cardiac monitoring, obtain a 12 lead ECG and arrange continuous ECG monitoring immediately. ***Do not let obtaining an ECG delay proceeding with treatment below.***
Stop all potassium containing medications or medications that can increase potassium.*
Repeat serum potassium every 15 minutes until serum potassium below 6.5mmol/L for neonate or 5.5mmol/L for infant over 1 month.

**Contact parent team prior to withholding any doses of Tacrolimus or Ciclosporin*

STEP 2: Give SALBUTAMOL to move extracellular potassium into cells	
Neonate	Nebulised Salbutamol 2.5mg, *or* IV salbutamol 4 microgram/kg/dose over 5 minutes, diluted to 2ml with sodium chloride 0.9%
Over 1 month to 14 years	Nebulised Salbutamol 2.5mg for < 10kg, 5mg for ≥ 10kg, *or* IV salbutamol 4 microgram/kg/dose over 5 minutes
Over 14 years/ adult	Nebulised Salbutamol 10mg, or IV salbutamol 4 microgram/kg/dose over 5 minutes

Nebulised salbutamol maybe repeated as needed - see salbutamol section for further decision support.

STEP 2: Give INSULIN/GLUCOSE to move extracellular potassium into cells	
Neonate	Add 0.1 units/kg soluble insulin (actrapid) to 1g/kg of glucose Give over 10 minutes. 1g/kg glucose = 10ml/kg 10%, 5ml/kg 20%, 2ml/kg 50%
Over 1 month to 14 years	Add 0.1 units/kg soluble insulin (actrapid) to 1g/kg of glucose Give over 10 minutes 1g/kg glucose = 10ml/kg 10%, 5ml/kg 20%, 2ml/kg 50%
Over 14years/ adult	Add 10 units of soluble insulin (actrapid) to 50ml glucose 50% or 125ml glucose 20%. Give over 5-10 minutes

Monitor blood glucose every 30 minutes for six hours.

See Monograph/Appendix C for preparation; always use an insulin syringe.

Insulin/Glucose is as effective as Salbutamol (in terms of speed of onset and expected drop in potassium), but takes longer and is more complex to prepare. Therefore, use of Salbutamol is preferred over Insulin/Glucose in the first instance.

See section 4.3 and Appendix C for further decision support.

If metabolic acidosis, consider IV sodium bicarbonate 8.4% - see section 4.7 for further decision support and mechanism of action.

2.3 Management of Mild Hyperkalaemia- GREEN/STEP 3

Start therapy here if the patient is stable/asymptomatic or there are no ECG changes with potassium 5.5 - 6mmol/L (over 1 month age) or 6.5-7mmol/L (neonates).

If no cardiac monitoring, obtain a 12 lead ECG and arrange continuous ECG monitoring.

Stop all potassium containing medications or medications that can increase potassium.*

**Contact parent team prior to withholding any doses of Tacrolimus or Ciclosporin*

STEP 3: Give SALBUTAMOL to move extracellular potassium into cells	
Neonate	Nebulised Salbutamol 2.5mg
Over 1 month to 14 years	Nebulised Salbutamol 2.5mg for < 10kg, 5mg for ≥ 10kg
Over 14 years/ adult	Nebulised Salbutamol 10mg

Nebulised salbutamol maybe repeated as needed

STEP 3: Give FUROSEMIDE to remove potassium from the body	
Neonate	IV Furosemide 1mg/kg/dose over 5 minutes
Over 1 month to 14 years	IV Furosemide 1mg/kg/dose to maximum of 20mg over 5 minutes (or 0.5mg/kg/min)
Over 14 years/ adult	IV Furosemide 20mg over 5 minutes

STEP 3: Give CALCIUM RESONIUM to remove potassium from the body	
Neonate	Calcium resonium rectally 125-250mg/kg/dose four times a day
Over 1 month to 14 years	Calcium resonium oral or rectally 125-250mg/kg/dose four times day
Over 14 years/ adult	Calcium resonium oral or rectally 15 grams four times a day

If adrenal insufficiency suspected, consider hydrocortisone 1-2mg/kg/dose (maximum 100mg) - see section 4.6 for further decision support and mechanism of action.

3. Potassium Homeostasis

Most of the potassium in the body is found in the intracellular fluid, with potassium being the principal intracellular cation.

Increased tissue damage e.g. rhabdomyolysis, rapid tissue necrosis or burns can therefore cause release of the intracellular potassium into blood.

Potassium is kept inside the cells by the negative voltage created by the active transport of cations out of the cell via the Na/K-ATP pump. Three sodium ions are exchanged out for two potassium ions kept in ($K_{in} > K_{out}$). Various factors affect the Na/K-ATP activity including insulin, glucagon, catecholamines, aldosterone, acid-base status, plasma osmolality and intracellular potassium levels.

In acidosis the body uses potassium to decrease excess extracellular hydrogen ions by moving potassium out of the cell and hydrogen ions into cells.

Most potassium (90%) is excreted by the kidneys, therefore decreased renal function can lead to hyperkalaemia. Chronic renal disease can lead to a reduction of aldosterone responsiveness with reduced sodium and water delivery to the distal tubules leading to hyperkalaemia.

3.1 Causes of hyperkalaemia

- Artefact of collection process or technique
- Oliguria/anuria
- Acidosis
- Diabetic ketoacidosis
- Tumour lysis syndrome
- Burns
- Crush injuries/rhabdomyolysis/rapid tissue necrosis
- Massive blood transfusion
- Iatrogenic potassium administration - IV or oral
- Medication

3.2 Medications to stop/avoid in hyperkalaemia

Medications requiring review in patients with hyperkalaemia and mechanism of action in brief include:

- Tacrolimus or ciclosporin - **contact parent team prior to discuss withholding of any doses**. Inhibit Na/K-ATPase necessary for collecting duct potassium secretion
- Potassium sparing diuretics - spironolactone - inhibits aldosterone receptor activation; amiloride - blocks collecting duct apical sodium channel thereby decreasing gradient for potassium, secretion

- Trimethoprim or co-trimoxazole - blocks collecting duct apical sodium channel thereby decreasing gradient for potassium secretion
- ACE inhibitors e.g. captopril/lisinopril/enalapril - inhibit conversion of angiotension I to angiotensin II
- Non selective beta-blockers e.g propranolol, labetalol - inhibit renin release
- Suxamethonium - shift of potassium from muscle cells into serum
- Digoxin Inhibit Na/K-ATPase necessary for collecting duct potassium secretion
- Heparin - inhibits aldosterone synthetase which is the rate limiting enzyme for aldosterone synthesis
- Macrogol laxatives e.g. Movicol or Laxido- increased potassium intake
- Aspirin/ NSAIDs- inhibits prostaglandin stimulation of collecting duct potassium secreation and inhibit renin release
- IV fluids containing potassium – increased potassium intake
- Arginine hydrochloride – increased potassium shift out of cells

4. Principles of drug therapy involved in hyperkalaemia control

4.1 Calcium

- Calcium is given to reduce the threshold potential of cardiac cells by restoring the normal gradient with the resting potential that has been increased with the elevated potassium levels. *Calcium does not affect potassium levels.*
- Calcium should work within 3 minutes and its action lasts for 30 - 60 minutes.
- If the patient is taking digoxin or digoxin toxicity is suspected, calcium must be given at a slower rate, over 30 minutes. Calcium may precipitate myocardial digoxin toxicity even at normal digoxin levels. Digoxin toxicity can cause an increase in potassium and arrhythmias. Treatment with digoxin antibody fragments (FaB) may be considered only after discussion with Consultant Cardiologist or Intensivist.
- Calcium gluconate is the preferred choice due to the risk of severe necrosis if calcium chloride extravasates. Calcium gluconate should be given centrally if there is central access, via the most distal lumen available. If no central access is available, dilute it to five times volume - e.g. 0.5ml/kg/dose dilute to 2.5ml/kg/dose.
- Calcium chloride can only be given by central access.

4.2 Salbutamol

- Salbutamol causes extracellular potassium to move into cells.
- Expected decrease of potassium is 0.5-1mmol/L within 15-30minutes of administration, with a duration of action of 2 hours.
- Not everybody responds to salbutamol, therefore insulin/glucose therapy should be given alongside salbutamol in patients with severe hyperkalaemia and also considered in moderate hyperkalaemia. Patients taking digoxin or beta-blockers have a decreased effectiveness of salbutamol due to prevention of intracellular buffering of potassium.

About 40% of haemodialysis patients show resistance to potassium lowering with salbutamol therapy alone.

- Salbutamol and insulin/glucose therapy have an additive effect when used together, with salbutamol lowering the hypoglycaemic action of insulin.
- Using salbutamol may give more time to put other potassium removal methods into place - e.g. furosemide, calcium resonium, dialysis or haemofiltration.

4.3 Insulin/ Glucose Therapy

- Insulin causes extracellular potassium to move into cells. Glucose does not have an effect on potassium, but is given to combat the hypoglycaemic actions of the insulin.
- Insulin/glucose decreases potassium by 0.6-1mmol/L within 15 minutes of administration, with maximum effect at 30-60minutes. The effects last for up to 4 hours. Where the potassium remains high, a second dose can be given after 30 minutes or an insulin infusion of 0.1units/kg/hour can be considered alongside a glucose infusion to avoid hypoglycaemia.
- Insulin has a dose dependent effect with its action mediated by activation of the Na/K-ATPase pump, pushing potassium back intracellularly. This is thought to occur by insulin increasing the availability of intracellular sodium by its effect on the Na/H exchanger.
- As insulin's hypoglycaemic effects can last longer than the stat glucose 1g/kg given alongside it, regular 30 minute blood glucose monitoring is needed for 6 hours after the insulin is complete. A glucose infusion should be initiated in neonates and younger infants and considered in the older child and adult.
- For patients with blood sugars above 15mmol/L, a glucose infusion is not required but regular blood glucose monitoring must be undertaken if there is an insulin infusion running.
- Where a patient has central access this must be used when glucose 50% is administered to provide the 1g/kg of glucose alongside the insulin. If there is no central access, 10ml/kg of glucose 10% can be used if patient factors allow the extra fluid.

4.4 Furosemide

- Furosemide, along with iv fluids in patients with normal renal function, increases renal potassium excretion. Furosemide will not work in end stage renal failure patients who are anuric or anephric.
- For patients who are not anephric or in renal failure, onset of diuresis will be seen in 5 minutes with an iv dose, with peak effect within 30 minutes.
- The extent of potassium excreted is unreliable and therefore cannot be assumed to be a dose related effect and therefore furosemide use is an adjunct to above therapies.

4.5 Calcium Resonium

- Calcium resonium works as a cation exchange resin promoting potassium elimination via the gastrointestinal tract. It can be given orally or rectally, with rectal being more effective as the colon is the major site of action.
- Acute control of high potassium will not be achieved by calcium resonium as it will be at least 2 hours before an effect on potassium is seen, hence its place in the management algorithm. Its peak effect is at 4-6 hours post dose and requires four times a day dosing. A drop in serum potassium by 2mmol/L can be achieved.
- Calcium resonium should not be used if there has been recent GI surgery, or there is a risk of constipation or impaction. See Appendix B for prescribing and administration details

4.6 Use of Steroids

- In severe hyperkalaemia of unknown cause, or if there is a suspicion of adrenal insufficiency/low cortisol, hydrocortisone can be considered at a dose of 2mg/kg stat (maximum 100mg).
- Aldosterone, a mineralocorticoid, controls the excretion of potassium in the renal tubules via the Na/K-ATPase activity in the tubule cell membranes, leading to an increase in sodium reabsorption. This generates a higher negative potential in the lumen thus driving an increase in potassium and hydrogen excretion. Low aldosterone levels leads to a decrease in potassium excretion and therefore hyperkalaemia.
- Fludrocortisone is an aldosterone analogue which can be used for increased renal potassium elimination. It is of benefit in hyporeninaemia or hypoaldosteronism and has been used chronically for patients taking ciclsporin or tacrolimus with persistently high serum potassium.

4.7 Use of Sodium Bicarbonate

- Bicarbonate works where the patient is acidotic or has a low serum bicarbonate.
- By alkalinising the serum/correcting the acidosis there is an indirect movement of potassium into the cells via the H+/K+ exchange mechanism.
- Bicarbonate can increase potassium excretion by alkalosis upregulating potassium channels in the distal nephron.

Appendix A - Pseudohypoaldosteronism

Any patient who presents to the ED with pseudohypoaldosternism must be discussed with the Consultant Endocrinologist on call

- Patients usually require a high sodium intake (such as Solution G) to prevent them from being unwell (1ml of enteral solution G contains 1.34mmol)
- The first signs of becoming unwell are vomiting (causing hyperkalaemia and acidosis) and/ weight loss

ALL patients who present to the Emergency Department must be seen and assessed urgently:

- Check Serum Sodium, Potassium and Bicarbonate via blood gas machine
- Give 20ml/kg sodium chloride 0.9% to to correct any signs of shock
- If no cardiac monitoring obtain 12-lead ECG and arrange continuous ECG monitoring.
- Confirm usual daily dose of solution G that patient takes.

Potassium Level	**Management**
Over 8mmol/L	Go to RED pathway **AND give 20ml/kg of "Pseudoaldosteronism Emergency Bag 2 Sodium 10mmol/kg" over 2 hours**. Contact ITU for help. Then start solution G IV.
7.0 - 7.9mmol/L	Go to YELLOW pathway AND give 20ml/kg of "Pseudoaldosteronism Emergency Bag 1 Sodium 5mmol/Kg" over 2 hours. Then start solution G IV.
6.0 - 6.9mmol/L	Go to GREEN pathway AND give 20ml/kg of "Pseudoaldosteronism Emergency Bag 1 Sodium 5mmol/Kg" over 2 hours. Then start solution G IV.

Preparation of the Emergency bags:

Pseudoaldosteronism Emergency Bag 2 Sodium 10mmol/kg Remove 50ml from a 5% glucose 500ml bag. Add 50ml sodium chloride 30% to the 5% glucose bag. Label as "Emergency Bag 2 Sodium 10mmol/kg" 20ml/kg of this bag gives 10mmol/kg sodium chloride.

Pseudoaldosteronism Emergency Bag 1 Sodium 5mmol/kg Remove 25ml from a 5% glucose 500ml bag. Add 25ml sodium chloride 30% to the 5% glucose bag. Label as “Emergency Bag 1 Sodium 5mmol/kg” 20ml/kg of this bag gives 5mmol/kg sodium chloride.

Calculating IV solution G rate in ml/hour:

$$\frac{\text{Patients total daily solution G oral volume} \times 5}{24}$$

If the serum sodium is less than 140mmol/L, the endocrine team will direct what increase in rate of IV solution G would be needed.

Preparation of IV solution G Remove 65ml from a 5% glucose 500ml bag. Add 50mls sodium bicarbonate 8.4% and 15mls sodium chloride 30%. Label as “IV solution G”.

Appendix B – Calcium Resonium

Prescribing And Administration of **CALCIUM RESONIUM** for doses less than 15 grams

Presentation:

Calcium resonium powder, each scoop gives a 15 gram dose

Prescribing:

Prescribe as calcium resonium, adding a colonic irrigation six hours post dose for the rectal route- see example below.

Dose as per BNFc:

Orally over 2 month 0.25 – 0.5 gram/kg/dose up to 6 hourly (maximum 60 grams/ day). Round dose to nearest 0.5g.

Rectally: 0.25 – 0.5 gram/kg/dose up to 6 hourly (maximum 30 gram/day). Round dose to nearest 0.5g.

Administration:

- Oral or NG route: add one scoop = 15 gram to 30ml of water and mix well- this gives a 1 gram in 2ml solution. Immediately draw up the dose required into an oral syringe. Give the dose and if given by feeding tube, flush tube with at least 5ml water.
- Rectal route: add one scoop = 15 gram to 75ml water, mix well- this gives a 1 gram in 5ml solution. Immediately draw up dose required and give via rectal tube. The dose should be retained in the rectum for 6 hours. After 6 hours a rectal washout using sodium chloride 0.9% should be done.

Monitoring/Other information:

The oral route should not be used in infants less than 2 months of age due to the risk of bowel obstruction and necrosis. Consider using a laxative such as lactulose for patients prescribed calcium resonium via the oral route.

Potassium levels should be taken prior to each dose. Therapy should be stop once the potassium levels reach 5mmol/L.

Example

5kg NBM infant has a potassium of 6.2mmol/L. Prescribe calcium resonium 1 gram every eight hours until the potassium reaches a level of 5mmol/L.

Prepare and administer as follows

Add one 15 gram scoop of calcium resonium to 75ml of water. Draw up 5ml of the solution to give 1 gram. Give the dose via rectal tube. Six hours later give rectal washout as prescribed.

Appendix C

INSULIN/ GLUCOSE for HYPERKALAEMIA only

Presentation

Soluble insulin (Actrapid®) 100 units in 1 ml
Glucose 10%, glucose 20% or glucose 50% 500 ml bag

Prescribing

First administer of 0.5 ml/kg of calcium gluconate 10% (to max 20 ml).
Under 14 years old: dose of insulin is 0.1unit/kg with 1 g/kg of glucose simultaneously over 10 minutes. (1g/kg glucose = 10ml/kg 10%, 5ml/kg 20%, 2ml/kg 50%)
14 years and over: dose of insulin is 10 units insulin in 50ml glucose 50% or if no central access add 10 units insulin to 125ml glucose 20%
Prescribe on the once only section of the drug chart.

Storage

Insulin stored in fridge
Glucose infusion bags stored at room temperature

Preparation/ Dilution

ALWAYS USE AN INSULIN SYRINGE

Under 14 years old: Using an **insulin syringe** draw 1ml of 100 units in 1ml insulin into an insulin syringe and make up to 10ml using sodium chloride 0.9%. This gives a 10 unit in 1ml solution.
Then dilute this insulin (10 units in 1ml) with **one** of the glucose strength options below.
Select next step based on the volume to give patient and type or IV access available (see Route of Administration below).

Using 50% glucose 500 ml
1.) Add 25 units of insulin to 500 ml. Label and shake well.
2.) Run 2 ml/kg of this solution over 10 minutes via central line if available.

Using 20% glucose 500 ml
1.) Add 10 units of insulin to 500 ml. Label and shake well.
2.) Run 5 ml/kg of this solution over 10 minutes via central line if available.

Using 10% glucose 500 ml
1.) Add 5 units of insulin to 500 ml. Label and shake well.
2.) Run 10 ml/kg of this solution over 10 minutes

If volume to be given is less than 50 ml, transfer the insulin/glucose solution to a syringe and give via syringe pump.

14 years and over: Using an **insulin syringe** add 10 units of insulin to 50ml glucose 50% or 125ml glucose 20%.

Route of Administration

Central Administration Required	Central Administration Preferred (only give peripherally if central access not available)	Central *or* Peripheral Administration Acceptable
Insulin in Glucose 50%	Insulin in Glucose 20%*	Insulin in Glucose 10%

*If there is only peripheral access, insulin/glucose 20% may be given peripherally due to the urgency of treatment.

Rate of Administration

Over 10 minutes

Stability

Use immediately.

Flushes

Sodium chloride 0.9%

Common compatibilities at terminal Y-site

IV maintenance solution containing glucose/sodium chloride.

Monitoring/ Other comments

Blood sugars must be monitored before, during and after infusion. Check the blood sugar level 5 minutes after completing the infusion, then every 15 mins for the first hour, then hourly for a further 3 hours if stable. Watch for late hypoglycaemia.
ECG monitoring will be set up in advance, continue this monitoring during and for 4 hours after infusion.
Potassium levels should be re-checked immediately post infusion and at regular intervals for four to six hours.
Ensure all potassium containing products are withheld, until full medical review.

Extravasation risk

Glucose	Hyperosmolar	Extreme of pH	Vasoactive	Vesicant
10%	No	pH 3-5	No	No
20%	Yes			
50%	Yes			

Calculation example

6 kg infant with potassium of 6.7 mmol/L with ECG changes.
0.5 ml/kg of calcium gluconate 10% stat given, needs insulin 0.6 units with 6 g glucose over 10 minutes. Infant only has peripheral access and is not fluid restricted
Prescribe as follows on the once only part of the drug chart.

PRESCRIPTION FC

Date and Time to be given	Medicine (Approved Name)	Dose	Route	S
1/5 09:00	INSULIN with	0.6 units	IV	
1/5 09:00	GLUCOSE 10%	6 grams	IV	
Follow insulin for hyperkalamaemia monograph for preparation. Give over 10 minutes				

Administer as follows:
Transfer 100 units in 1ml insulin from **insulin syringe** into 10 ml syringe and make up to 10 ml using sodium chloride 0.9% to give 10units in 1ml insulin.
Add 0.5 ml of the diluted 10 units in 1ml insulin solution to a 500 ml bag of glucose 10%. Label as per Trust policy. Set pump to run at 360 ml/ hour for 10 minutes only.
Ensure blood sugar and potassium level is re-checked within 5 minutes of completing infusion.