GUIDELINES AND AUDIT
IMPLEMENTATION NETWORK

Guidelines for the Treatment of Hyperkalaemia in Adults

August 2014

This document is a revision of the original Guidelines for the Treatment of Hyperkalaemia in Adults developed by GAIN in 2009

PREFACE

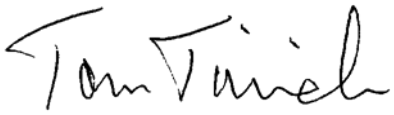
Guidelines for the Treatment of Hyperkalaemia in Adults

These guidelines have been published by the Guidelines & Audit Implementation Network (GAIN), which is a team of health care professionals established under the auspices of the Department of Health, Social Services & Public Safety in 2008.

The aim of GAIN is to promote quality in the Health Service in Northern Ireland, through audit and guidelines, while ensuring the highest possible standard of clinical practice is maintained.

This guideline is a review of the GAIN 2009 guideline and was produced by a sub-group of health care professionals from varied backgrounds and was chaired by Professor Gary McVeigh, Professor of Cardiovascular Medicine.

GAIN wishes to thank all those who contributed in any way to the development of these guidelines.



Dr T Trinick

Chairman of GAIN

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FOREWORD

The reported incidence of hyperkalaemia in hospitalised in patients is between 1% and 10%. It is the most serious of all electrolyte abnormalities as the symptoms can be non-specific or absent, even in severe hyperkalaemia, before causing cardiac arrest. Most cases are associated with medicines that inhibit the renin-angiotensin system or interfere with renal function; especially in the setting of pre-existing renal disease and/or acute kidney injury.

This guideline updates the previous 2009 GAIN Guideline for the Treatment of Hyperkalaemia in Adults. The major changes in the updated guidance are revised ranges for hyperkalaemia severity and changes to the customised kit to treat hyperkalaemia. The instructions accompanying the kit provide clear and concise information that will enable physicians to safety and effectively manage patients presenting with hyperkalaemia. In particular, the safe and effective use of insulin / glucose in the treatment of hyperkalaemia is highlighted with emphasis placed on the requirement to always use an insulin syringe and have a check of volume by a senior nurse before insulin is administered to the patient.

I would like to thank Miss Sharon O'Donnell, Medicines Governance Pharmacist and Professor Peter Maxwell, Consultant Nephrologist for their help in producing this updated guidance.

Professor G McVeigh

Professor in Cardiovascular Medicine

The reported incidence of hyperkalaemia in hospitalised patients is between 1 and 10%. **The vast majority of cases are related to patients prescribed angiotensin converting enzyme inhibitors (ACE) or angiotensin II receptor blockers (ARBs) in conjunction with spironolactone with pre-existing or new renal failure**. Most other cases are related to potassium supplementation and prescription of diuretics/medicines with potassium-sparing properties.

AETIOLOGY OF HYPERKALAEMIA

Renal Causes

• Acute kidney injury or chronic kidney disease

• Hyperkalaemic renal tubular acidosis (type IV)

• Mineralocorticoid deficiency (hypoaldosteronism states)

• Medicines that interfere with potassium excretion (amiloride, spironolactone, eplerenone, trimethoprim)

• Medicines that interfere with the renin-angiotensin system (angiotensin converting enzyme inhibitors, angiotensin II receptor blockade, nonsteroidal anti- inflammatory agents, heparin)

Transcellular shift (intracellular to extracellular compartment)

• Acidosis (including diabetic ketoacidosis)

• Medicines (digoxin poisoning, suxamethonium, beta-blockade)

Increase circulating potassium - Exogenous or Endogenous

• Exogenous (potassium supplementation)

• Endogenous (tumour lysis syndrome, rhabdomyolysis, trauma, burns)

Pseudohyperkalaemia

• Prolonged tourniquet time

• Test tube haemolysis

• Marked leucocytosis and thrombocytosis (measure plasma not serum concentration in these disease states)

• Sample taken from a limb infused with IV fluids containing potassium

ASSESSMENT OF THE PATIENT

Is this 'true' hyperkalaemia?

A repeat serum potassium should be ordered urgently, especially if hyperkalaemia is an unexpected or isolated finding and there are no ECG signs of hyperkalaemia, to exclude pseudohyperkalaemia.

How severe is the hyperkalaemia?

Hyperkalaemia is classified as –

• mild hyperkalaemia ($[K^+]$ 5.5 – 5.9 mmol/L)

• moderate hyperkalaemia ($[K^+]$ 6.0 - 6.5 mmol/L) or

• severe hyperkalaemia ($[K^+] \geq 6.5$ mmol/L) or if ECG changes or symptoms (muscle weakness or flaccid paralysis palpitations, paraesthesia) occurring at **ANY** level of serum potassium ≥ 5.5mmol/L especially if associated with hypoxia

Situations associated with a rapid rise in potassium (acute kidney injury, rhabdomyolysis and hypoxia of any cause) are more strongly associated with the development of cardiac conduction disturbances.

Mild hyperkalaemia is common and often well tolerated in patients with chronic kidney disease.

Is urgent treatment required?

Urgent treatment is required if the serum potassium is ≥ 6.5 mmol/L OR hyperkalaemia is accompanied by ECG changes or above symptoms - even in the presence of mild hyperkalaemia ($[K^+]$ 5.5 – 5.9 mmol/L).

Why has the patient got hyperkalaemia?

A thorough medical history focusing on a history of renal disease and determination of the medications or fluids prescribed will often reveal the cause of the hyperkalaemia. Examine for bladder distension and prostatic hypertrophy. Catheterise if appropriate.

MONITORING THE PATIENT

• A 12-lead ECG is mandatory. Cardiac monitoring should be:

- considered if hyperkalaemia is mild (serum $[K^+]$ > 5.5-5.9 mmol/L)

- thought of as good practice if moderate hyperkalaemia (serum $[K^+]$ 6.0-6.4 mmol/L)

- mandatory if severe hyperkalaemia (serum $[K^+]$ ≥ 6.5 mmol/L)

• The ECG does not always demonstrate changes, even in the presence of severe hyperkalaemia, so a normal ECG does not obviate the need for therapy. However, the presence of ECG findings should be a strong impetus for urgent action

• The most worrying findings are decreased or absent P-waves, PR prolongation, QRS widening, sine wave QRST, AV dissociation or asystole. It is often difficult to judge if T waves are truly peaked and this finding on its own should not be an automatic indication for urgent therapy

Monitor urea, electrolytes and glucose at regular intervals. Additional blood investigations, including creatinine kinase and blood gas analysis, are performed if appropriate.

TREATMENT OF HYPERKALAEMIA

Stop further potassium accumulation

Stop all potentially offending medicines immediately. These include ACE inhibitors, angiotensin receptor blockers, potassium retaining diuretics e.g. spironolactone, amiloride – (in co-amilofruse), eplerenone, trimethoprim, NSAIDs and potassium containing laxatives (Movicol®, Klean-Prep®, Fybogel®). Beta-blockers and digoxin should also be stopped as they prevent intracellular buffering of potassium and reduce the effectiveness of insulin-glucose and beta-2 agonists.

Place the patient on a low potassium diet. It is imperative that whilst waiting for this diet that the patient does not consume fruit juice, fruits, chocolate, fruit gums, biscuits, coffee or potatoes.

Use the Hyperkalaemia Kit

Information on how to use the kit is contained in Appendix 1. The kit contains:

• 5 x 10ml calcium gluconate 10% ampoules

• 2 x 50ml glucose 50% vial

• 20 x salbutamol 2.5 mg nebules

• 2 x insulin syringes

• 2 x Chemoprotect syringes

NB Actrapid® insulin is stored in the pharmaceutical refrigerator.

TREATMENT OF HYPERKALAEMIA

Protect the cardiac membrane (use of intravenous calcium)

Give 10ml of calcium gluconate 10% intravenously over 2 minutes (The hyperkalaemia kit contains five 10ml calcium gluconate 10% ampoules)

• This intervention will not lower the potassium, but if ECG changes are present, there should be improvement seen within 1 to 3 minutes

• If improvement does not occur a further 10 ml of calcium gluconate 10% can be given intravenously every 10 minutes until the ECG normalises (patients may require up to 50 ml). The effect of this intervention is transient (approximately 30-60 minutes)

• It is important to note that if the patient is taking digoxin and the decision is made that calcium gluconate is required, it should be given slowly over 20 minutes mixed in 100 ml of glucose 5% as rapid calcium administration may precipitate myocardial digoxin toxicity

• Digoxin toxicity can cause hyperkalaemia and arrhythmias and urgent haemodialysis or the administration of digoxin antibody (Fab) fragments may represent the preferred approach. Consult with senior colleagues

TREATMENT OF HYPERKALAEMIA

Shift the potassium from the blood into the cell (use of insulin and glucose)

• Withdraw 10 units of Actrapid® insulin using an INSULIN syringe. There are two insulin syringes in the hyperkalaemia kit.

• Always obtain a check of volume from a senior nurse before proceeding.

• Add to 50 ml glucose 50% vial as shown in the Standard Operating Procedure (SOP) in the hyperkalaemia kit (Appendix 1).

• Administer by slow IV injection over 5 minutes

• The onset of the hypokalaemic action occurs within 15 minutes and lasts at least 60 minutes. The reduction in potassium observed ranges from 0.6 to 1.0 mmol/L

• Monitor urea and electrolytes (U&Es) 30 minutes, one, two, four and six hours after each administration of insulin/glucose

• If the serum glucose is ≥15 mmol/L then administration of additional glucose with insulin is not required

• The effects of administering insulin/glucose are observed in 15 minutes and last 4-6 hours

• Monitor blood glucose 15 and 30 minutes after starting the infusion and then hourly up to six hours after completion of the infusion as delayed hypoglycaemia is commonly reported when less than 30g of glucose is administered with insulin

• In some circumstances (circulatory shock, diabetic ketoacidosis) capillary glucose testing with a glucometer may not provide an accurate or reliable measure of blood glucose. In these circumstances or if the glucose level measured by capillary testing does not correspond with the clinical picture a venous blood sample should be sent to the laboratory for analysis. A drop of blood from the venous sample can be tested using the glucometer to assess if a discrepancy exists with the capillary measurement. Comparison of the venous sample with the laboratory sample will confirm the glucometer is properly calibrated

TREATMENT OF HYPERKALAEMIA

Shift the potassium from the blood into the cell (use of salbutamol)

• Administer 10mg of nebulised salbutamol. (There is a box of 20 salbutamol 2.5mg nebules in the hyperkalaemia kit)

• Salbutamol for nebulisation is normally 2.5 mg/2.5ml strength and the nebuliser chamber will hold 10 ml i.e. 10 mg salbutamol. This will lower the potassium by 0.5 to 1.0 mmol/L by 15-30 minutes with the effect lasting at least 2 hours

• 20 mg of nebulised salbutamol may be more effective than a 10 mg dose at 2 hours. The lower dose is preferable in patients with ischaemic heart disease. There is no difference in the maximum hypokalaemic effect when nebulised salbutamol is compared with salbutamol 500 micrograms administered intravenously

• Salbutamol may not lower potassium in all patients and some studies show that up to 40% of dialysis dependent patients are resistant to these agents. The hypokalaemic response is also weakened in patients taking beta-blockers and digoxin. Therefore salbutamol is not recommended as a single agent to treat hyperkalaemia

• There is evidence that the combination of nebulised salbutamol and insulin/glucose display additive effects in lowering the serum potassium, with a weakening of the hypoglycaemic action of insulin. These interventions buy time for more definitive therapy as they do not remove potassium from the body

Sodium bicarbonate - **not recommended.** While this has been a traditional treatment for hyperkalaemia, many studies show that sodium bicarbonate fails to lower the serum potassium. A reduction in potassium will not occur within 60 minutes of administration. There are also potential risks in giving sodium bicarbonate in terms of volume and sodium overload and tetany in patients with chronic kidney disease and co-existent hypocalcaemia. The risks outweigh any potential benefit.

REMOVAL OF POTASSIUM FROM THE BODY

Haemodialysis

If despite the treatment measures described the potassium remains greater than 6.5 mmol/L or if pathological ECG changes/symptoms persist, the renal team should be contacted to arrange urgent dialysis if appropriate.

• Haemodialysis is the most effective and definitive but invasive method in treating hyperkalaemia. It is strongly considered if hyperkalaemia is severe (level debated but ≥ 6.5 mmol/L) and other first-line agents have been unsuccessful, or if there is ongoing tissue damage and continued release of intracellular potassium is expected

• It is important to enlist the help of renal team at an early stage in these circumstances

N.B Medicines administered for the treatment of hyperkalaemia must be prescribed on the medicine prescription chart (Kardex). The term ‘units’ must not be abbreviated when prescribing insulin.

CLINICAL PEARLS

• Always consult with the senior doctor responsible for the patient with hyperkalaemia

• Always stop medicines/food and fluids that exacerbate hyperkalaemia (ACE/ARBs, spironolactone, potassium sparing diuretics, digoxin, NSAIDs)

• Careful cardiac monitoring and repeated blood testing including glucose is mandatory

• A negative ECG does not negate the need for calcium gluconate and insulin/glucose in severe cases

• Digoxin toxicity (probable in renal failure) can increase serum potassium.

Calcium gluconate MUST be administered SLOWLY over 20 minutes mixed in 100 ml glucose 5% to prevent myocardial digoxin toxicity. Alternatively, and perhaps safer, urgent dialysis and administration of digoxin antibody (Fab) fragments is preferred. Consult with senior colleagues

• Insulin can be administered as a single agent without 50 ml glucose 50% if glucose >15 mmol/l

• If doubts exist confirm the accuracy of capillary blood glucose values by using a sample of venous blood for glucometer testing and sending the remainder of the sample to the laboratory for analysis

• Beta-2 agonists may not lower serum potassium especially in dialysis patients or those taking beta-blockers or digoxin. Not recommended as a single agent

• Calcium gluconate/insulin/beta-2 agonists are not definitive therapies - they simply buy time for more definitive therapy

• Ensure that the patient is placed on a ‘low potassium diet’ and ban the patient from consuming food with a high potassium content e.g. chocolate, fruit juices, until a dietetic assessment has been undertaken

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APPENDIX 1

Membership of the GAIN Sub-Group on the Treatment of Hyperkalaemia in Adults

Chairman

Prof Gary McVeigh	Consultant Physician	Belfast HSC Trust

Members

Prof Peter Maxwell	Consultant Nephrologist	Belfast HSC Trust
Ms Sharon O'Donnell	Medicines Governance Pharmacist	Belfast HSC Trust

Reviewers

Dr Niall Leonard	Consultant Nephrologist	South Eastern HSC Trust
Dr Neal Morgan	Consultant Nephrologist	Southern HSC Trust
Dr Robert Mullan	Consultant Nephrologist	Northern HSC Trust
Dr Ying Kuan	Consultant Nephrologist	Western HSC Trust

APPENDIX 2

How to make up 10 units of Actrapid® (soluble) insulin in 50ml glucose 50% vial using the hyperkalaemia kit

Protect the cardiac membrane: give 10ml of calcium gluconate 10% IV over 2 mins (NB if patient on digoxin and calcium gluconate required, give slowly over 20mins in 100ml of glucose 5%).

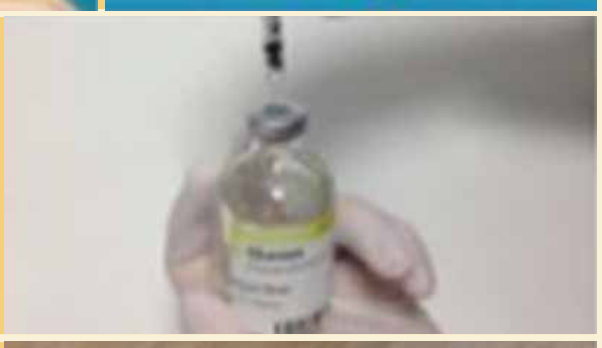
1. With the nurse in charge, obtain an Actrapid® vial from the pharmaceutical fridge.

2. Take the glucose 50% glass vial from the kit.
   Remove its protective cap.

3. Measure **10 units** of insulin using an insulin syringe from the kit:
   a. Draw the plunger back to the **10 unit** mark on the insulin syringe. Check the **10 units** of insulin obtained with the senior nurse on duty.
   b. Note **10 units** of insulin is contained in 0.1ml
   c. Record administration of this and other medicines used to treat hyperkalaemia on the Kardex. Ensure both signatures for double check are documented on the Kardex.

4. Inject the **10 units** of insulin into the glucose 50% glass vial.

5. Mix.



6. Take Chemoprotect® Spike from kit and remove protective sheath.

7. Pierce the glucose 50% glass vial with the Chemoprotect® Spike.

8. Screw the 50ml syringe onto Chemoprotect® Spike and draw up the contents of the vial.
9. Remove the 50ml syringe from Chemoprotect® Spike and expel air
10. Administer into a large vein by slow IV injection over 5 mins.

Monitoring – blood glucose should be measured after 15 and 30 minutes and then hourly for six hours. Check U&Es 30 minutes, one, two, four and six hours after each administration of insulin/glucose.

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APPENDIX 3 Treatment of Hyperkalaemia in Adults Wall Poster

Emergency management of hyperkalaemia in adults

REVISED 23 SEPTEMBER 2014

Incidence between 1 and 10% in hospitalised patients. Majority of cases are related to pre-existing or new renal failure, potassium supplementation or diuretics/drugs with potassium-sparing properties. Classified as mild (serum potassium 5.5 – 5.9 mmol/L), moderate (serum potassium 6.0 - 6.4 mmol/L), severe (serum potassium ≥6.5 mmol/L). Consult senior colleagues in clinical team if moderate or severe hyperkalaemia present i.e. serum potassium ≥6.0 mmol/L.

COMMON CAUSES OF HYPERKALAEMIA IN ADULTS

RENAL CAUSES

- Acute Kidney Injury or Chronic kidney disease*
- Drugs inhibiting R-A-A system (ACE inhibitors, ARBs, NSAIDs, heparin)*
- Drug induced inhibition of potassium excretion (e.g. amiloride, spironolactone, eplerenone, trimethoprim)*
- Hyperkalaemic Renal Tubular Acidosis (RTA Type IV)*

TRANSCELLULAR SHIFT OF POTASSIUM

- Acidosis (including Diabetic Ketoacidosis)*
- Drugs (digoxin poisoning, suxamethonium)

INCREASED CIRCULATING POTASSIUM

- Exogenous potassium (potassium supplements in drugs)
- Endogenous (burns, trauma, rhabdomyolysis)

*** = MOST COMMON CAUSES**

STEP 1: COMPREHENSIVE HISTORY AND EXAMINATION to determine and treat reversible causes of hyperkalaemia: ALWAYS TREAT THE UNDERLYING CAUSE.

- Non-specific symptoms include fatigue, weakness, paraesthesia, palpitations (may be absent even with severe hyperkalaemia).
- Focus on past history of renal problems and medication usage: **Stop potassium containing fluids / foods and drugs inhibiting potassium excretion.**
- Exclude urinary tract obstruction (examine for bladder distension). Catheterise if appropriate.

STEP 2: QUESTIONS AND INITIAL INVESTIGATIONS

Q: Is hyperkalaemia really present?:
Pseudohyperkalaemia (e.g. haemolysed sample). Repeat potassium **urgently** but do not delay treatment if acute kidney injury present or **if hyperkalaemic ECG changes**.

Q: Is Emergency Treatment needed?:
Yes if ECG changes present (Peaked T waves, PR prolongation, decreased or absent P waves, QRS widening, AV block, sine wave QRST)
A normal ECG does not mean there is no need for therapy - the ECG can be normal in severe hyperkalaemia.
Yes if severe hyperkalaemia. Acute changes in potassium **are** more likely to cause cardiac arrhythmias.
A 12-lead ECG with **repeated** assessment of **glucose** (BM testing) and urea and electrolytes is mandatory. Creatinine kinase/blood gas analysis (if indicated).

STEP 3: MANAGEMENT **Use a hyperkalaemia kit**

1. Protect the Cardiac Membrane:

Administer 10ml calcium gluconate
10% solution IV over 2 minutes. Effects noted 1 to 3 minutes and last approximately 30-60 minutes. **Caution if patient taking digoxin.**

2. Shift Potassium into Cells:

(a) Insulin
Withdraw 10 units of Actrapid® insulin using an INSULIN syringe.

Always obtain a check of volume from a senior nurse before proceeding.
Add to 50ml glucose 50% and administer by slow IV injection over 5 minutes. Effects observed in 15 minutes and last 4-6 hours.
Monitoring – blood glucose should be measured after 15 and 30 minutes and then hourly for six hours.
Check U&Es 30 minutes, one, two, four and six hours after each administration of insulin/glucose.

(b) Beta 2 Adrenergic Therapy
Administer 10 mg nebulised salbutamol. Effect observed 15-30 minutes. May not always reduce serum potassium **and** not used as a single agent. Synergistic serum potassium lowering effect when used with insulin/glucose above.

Calcium gluconate, insulin and Beta-2 agonists buy time and can be repeated multiple times while definitive measures are pursued.

3. Stop potassium intake:

Stop potassium supplements and potassium containing drugs. Avoid potassium rich fluids or foodstuffs in diet.

4. Remove potassium from the body:

(a) Use dialysis
Only required in exceptional circumstances when severe hyperkalaemia persists despite appropriate management. Ask senior colleague to consult with renal team.

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