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University Hospitals Birmingham NHS
NHS Foundation Trust

Electrolyte – Hyperkalaemia: Diagnosis and Management

CATEGORY:	Clinical Guidelines
CLASSIFICATION:	Clinical
Controlled Document Number:	CG014
Version Number:	3
Controlled Document Sponsor:	Clinical Guidelines Group
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Approved By:	Clinical Guidelines Group
On:	May 2019
Review Date:	May 2022

Diagnosis and Management of Hyperkalaemia

High potassium identified (greater than 5.5 mmol/l)

K+ less than 6.5mmol/L (moderate = 6.0-6.4)

- Identify cause
- Where artefactual hyperkalaemia likely, repeat U&E in Li heparin tube or check venous sample on blood gas analyser
- Suspend or stop relevant drugs
- Correct hypovolaemia
- Refer dialysis and CKD stage 4/5 patients to renal team urgently

K+ greater than or equal to 6.5 (severe)

Perform ECG and venous blood gas (VBG) for K+, HCO3 and pH

Repeat K+ **less than 6.5mmol/**

Repeat K+ **greater than 6.5mmol/**

Major ECG abnormalities?
Conduction defect not pre-existing
Including absent P waves or wide QRS

NO

YES

Calcium gluconate 10% **30 mL** IV over 5 min.
Continuous ECG monitoring

Causes of hyperkalaemia

1. Kidney disease (existing dialysis patients, stage CKD4/5 patients and AKI stage 2-3),
2. Drugs e.g. spironolactone, ACE-inhibitors, ARBs, NSAIDs, ciclosporin, trimethoprim (especially combinations).
3. Release from cell: severe tissue damage (e.g. rhabdomyolysis and burns) and acidosis (e.g. diabetic ketoacidosis)
4. Artefact: release from blood cells e.g. haemolysis or delayed sample analysis (e.g. sent from out-patients).

1. Give Actrapid® 10 units IV in glucose 50% 50 mL IV over 10 min into a large vein. In hyperglycaemic patients (e.g. DKA), 50% glucose should not be given.
2. Give nebulised salbutamol 10mg
3. If volume deplete, give IV crystalloid bolus (500-1000ml). (but not in a dialysis patient).
4. If volume overloaded, give IV furosemide (50mg).
5. If metabolic acidosis pH less than 7.3/bicarb less than 20mmol/L, give 500mL 1.26% sodium bicarbonate over 1 hou (see below).
6. Discuss with renal team urgently. Existing dialysis patient will require urgent dialysis. Other patients may require dialysis, especially if oliguric or severe renal impairment.
7. Monitor urine output. Give additional IV crystalloid +/or IV furosemide to promote diuresis according to fluid status. Do not continue IV fluid once oliguria established
8. Recheck plasma potassium VBG (venous blood gas) at least 2 hourly (hyperkalaemia may recur)

Monitor CBGs, U&E and urine output.

If hyperkalaemia recurs discuss with renal team urgently

Insulin/glucose promotes temporary K+ entry into cells but does not cause excretion of excess total body K+. Only useful until underlying cause treated and potassium excreted/removed.

DO NOT REPEAT GLUCOSE/INSULIN EXCEPT IN CONSULTATION WITH RENAL TEAM (RISK OF SEVERE HYPOGLYCAEMIA)

Ion exchange resins are not recommended in the treatment of hyperkalaemia.

WHICH PATIENTS DOES THIS GUIDELINE COVER?

All adults including those aged 16 years or older.

FEATURES, CAUSES AND INVESTIGATION OF HYPERKALAEMIA

Symptoms and signs

- Often asymptomatic.
- Muscle weakness.
- Distal paraesthesia.
- Respiratory depression.
- ECG changes:
    - Peaked T waves.
    - QRS widening.
    - Reduced P wave amplitude.
    - First degree heart block, hemiblock (especially left anterior) right/left bundle branch block, bifasicular or trifasicular block.
    - Broad/bizarre QRS complexes; Sine wave QRS appearance
    - Ventricular tachycardia/fibrillation.
    - Asystole.

Causes

❖ **Renal retention – impaired excretion**

Acute or chronic renal impairment (AKI or CKD or both - ACKD)

Drugs which block the renin-angiotensin-aldosterone system:
Angiotensin converting enzyme(ACE) inhibitors
Angiotensin 2 receptor antagonists (ARBs).
Aldosterone antagonists: spironolactone, *eplerenone.*
Non-steroidal anti-inflammatory agents (NSAIDs).
Heparin.
Potassium-sparing diuretics: amiloride, triamterene

Mineralocorticoid deficiency:
Addison's disease.
Hyporeninaemic hypoaldosteronism.

Hyperkalaemic renal tubular acidosis.

❖ **Re-distribution into the extracellular fluid space**

Digoxin poisoning.
β blockers.
Succinylcholine.
Acidosis, including diabetic ketoacidosis.
Rhabdomyolysis.
Trauma.
Burns.

❖ **Increased dietary intake**

NB. Whilst hyperkalaemia must be taken very seriously, there are cases in which the serum/plasma concentration of potassium is factitiously elevated:

- Delayed centrifugation of blood sample (greater than 4 hrs post venepuncture).
- Haemolysis ex-vivo.
- Prolonged venous occlusion with a tourniquet.
- Sample taken from 'drip arm' into which potassium-containing fluids are being infused.
- Pseudohyperkalaemia: with marked leucocytosis or thrombocytosis.

Note:
The laboratory will comment when the sample has been knowingly delayed in transit for greater than 4 hours. Unfortunately, samples taken from patients attending the Outpatients Clinic or General Practice may well be subject to delays in transit: in these cases it is usually only necessary to recall the patient to hospital for an urgent repeat blood test and possible treatment when the serum potassium greater than or equal to 6.0 mmol/L. The laboratory will automatically measure the degree of haemolysis, and strike out the potassium value when the 'haemolysis index' is excessive. Pseudohyperkalaemia due to leucocytosis or thrombocytosis is seen only in serum samples. A paired plasma sample can be sent to the laboratory and will have a significantly lower, and usually normal, potassium concentration.

INVESTIGATIONS

- **Urgent repeat measurement** of urea/electrolytes/creatinine **by the laboratory**.
  Do not rely solely on electrolyte measurements from blood gas machines. If hyperkalaemia is confirmed then request the following investigations:
  - 12 lead ECG
  - Serum bicarbonate or arterial blood gases.
  - Glucose.
  - Creatine kinase.
  - Random cortisol if there is no obvious renal or drug related cause for hyperkalaemia.

  If Addison's is suspected clinically, this sample must be taken before hydrocortisone is administered and preferably a short Synacthen® test should be performed. It is not necessary to have the actual cortisol measurements before treating a suspected case of Addison's disease with hydrocortisone.

If the cause of the hyperkalaemia is not apparent following these investigations, and before investigating rarer causes of hyperkalaemia, seek advice from a Consultant Nephrologist or Biochemist.

Do not delay the treatment of those with serum potassium concentrations greater than or equal to 6.5 mmol/L and / or ECG abnormalities.

MANAGEMENT OF HYPERKALAEMIA

A summary of this management protocol is given as a Flow Chart at the start of this guidance.

- Severe hyperkalaemia can result in **life-threatening arrhythmias.**
- Always inform a doctor of at least SpR/StR seniority or above if the patient has a serum potassium greater than or equal to 6.5 mmol/L.
- The majority of cases of hyperkalaemia are related to the prescription of drugs which interfere with the renin-angiotensin-aldosterone system with pre-existing or new renal disease.
- Hyperkalaemia in patients known to the Nephrology service should be referred to the Renal Team as soon as possible.

DETAILED GUIDANCE

a. Serum potassium 6.0 to 6.4 mmol/L
Treatment is not urgent unless the patient has symptoms or ECG changes.

1. Obtain a 12 lead ECG. If there are abnormalities which may indicate an effect of hyperkalaemia, treat and follow-up as for those patients with serum potassium greater than or equal to 6.5 mmol/L AND give intravenous calcium gluconate 10% (see below).
2. If the cause of hyperkalaemia is not readily apparent and remediable, ask the Dietetic service to provide a low potassium diet (and avoid fruit, fruit juice, chocolate in the interim). The necessity of potassium restriction should be reviewed once the serum potassium has been normalised.
   Consider glucose/insulin or nebulised salbutamol for K^+ 6.0 – 6.4 if there is clinical reason to believe K^+ may remain at that level or rise further.
3. Find the cause:
   a. Review medical history, request appropriate investigations to determine the cause of the hyperkalaemia.
   b. Review prescriptions and withdraw any medication which may be contributing to the hyperkalaemia.
4. Follow-up: Monitor serum potassium at least daily until normal (or less than or equal to 5.5 mmol/L).

b. Serum potassium greater than or equal to 6.5 mmol/L – treat first
Obtain a 12 lead ECG and arrange ECG monitoring as soon as possible, but do not delay treatment to lower the serum potassium concentration.

1. **IF THERE ARE ECG ABNORMALITIES** DUE TO HYPERKALAEMIA give 30 mL 10% (w/v) calcium gluconate intravenously over 5 mins (see reference). The effect on the ECG should occur within 3 mins. Further doses of 10 mL 10% (w/v) calcium gluconate can be given intravenously if there is no improvement in the ECG, up to a maximum total dose of 50 mL. If the patient is taking digoxin, then the 10 mL 10% (w/v) calcium gluconate must be diluted with 100 mL 5% (w/v) glucose and given slowly over 20 mins.
2. Give soluble insulin (Actrapid®) insulin, 10 units and 50 mL 50% (w/v) glucose intravenously over 10 minutes into a large peripheral vein or central line.
3. Monitor capillary glucose <u>for six hours</u> due to the risk of late hypoglycaemia.
4. Give salbutamol 10 mg by nebuliser (10 mL of the 2.5 mg/2.5 mL strength solution). Nebulised salbutamol may not be effective in dialysis patients or those taking β blockers or digoxin.
5. <u>Find the cause</u>:
   a. Review medical history, request appropriate investigations to determine the cause of the hyperkalaemia.
   b. Review prescriptions and withdraw any medication which may be contributing to the hyperkalaemia.
6. <u>Follow-up</u>:
   Measure serum potassium regularly (for example two to four hourly, depending on level and rate of rise of potassium). Repeat measurements of urea / electrolytes / creatinine, bicarbonate, and glucose.

The reduction in the serum potassium concentration produced by intravenous insulin / glucose and nebulised salbutamol is similar (~ 0.9 mmol/L) and is sustained for approximately 2 hours. A combination of intravenous insulin/glucose and nebulised salbutamol can produce an additive reduction on serum potassium (~ 1.2 mmol/L).

The fall in serum potassium with both insulin/glucose and salbutamol will be maximal at 2 hours, after which the potassium concentration will increase again. These treatments, which can be repeated, only 'buy time' whilst the definitive underlying cause of the hyperkalaemia is determined and treated.

If there is no immediately apparent and remediable cause for the hyperkalaemia, ask the dietetic service to provide a low potassium diet (and avoid fruit, fruit juice, chocolate in the interim). Review need for dietetic changes once the serum potassium has been normalised.

Notes:
Intravenous sodium bicarbonate is not effective in treating acute hyperkalaemia and should not be used alone unless it is indicated for the treatment of an associated metabolic acidosis.

Calcium polystyrene sulphonate resin will reduce serum potassium, but the effect will take 24 hrs. The resin is given rectally (30g), retained for 9 hours and then removed by irrigation. Thereafter 15 g of the resin is given orally in water 3 to 4 times daily. Due to its slow action and difficulties in use, resin is generally only used in patients being managed conservatively. The resin is stored in the emergency drug cupboards or obtained via the pharmacy department.

Refer the patient to the Renal Team as a matter of urgency for an opinion. Haemodialysis or haemofiltration may be required. If dialysis/filtration unlikely to be started within a few hours, start calcium polystyrene sulphonate resin rectally (30g), retained for 9 hours and then removed by irrigation. Thereafter 15 g of the resin is given orally in water 3 to 4 times daily. The resin is stored in the emergency drug cupboards. Repeat the

administration of insulin/glucose or salbutamol to keep the potassium concentration < 6.0 mmol/L.

REFERENCE

CLINICAL PRACTICE GUIDELINES TREATMENT OF ACUTE HYPERKALAEMIA IN ADULTS.
UK Renal Association 2014:
https://renal.org/wp-content/uploads/2017/06/hyperkalaemia-guideline-1.pdf
accessed 21 May 2019.

Pages 43 – 48 discuss intravenous calcium salts.

Author	Version	Date	Changes
Mark Thomas	3	01/12/2018	Only two categories – moderate and severe hyperkalaemia - cutoff for severe ≥ 6.5 Added a "consider" Dex/Insulin for K 6.0 – 6.4 Use combined therapy for K ≥ 6.5 Added glucose monitoring for 6 hr if Dex/Insulin given. Guideline applies if 16 yr or older