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Acute Hyperkalaemia in adults

Click ⓘ for further information where highlighted

History and Examination

ABCDE, NEWS

History

Focus on past renal history and medication usage.

Hyperkalaemia is potentially life-threatening and requires prompt treatment to prevent complications.

Electrocardiogram (ECG)

Tall, peaked T-waves, followed by flattening of P-wave, prolongation of PR interval, QRS widening, and development of S-wave (See link for ECG example). **Note**: ECG changes can be rapid.

Arrhythmias (bradycardia, VT, VF)

Always perform 12-lead ECG above Potassium 6mmol/L

Risk of arrhythmia rises if Potassium> 6.5mmol/L, often a rapid progression to VF or asystole

ACTION: If ECG changes or symptoms are present, treat urgently. NB: Sudden death can occur in the absence of premonitory ECG changes (2)

Other signs and symptoms(1)

Usually asymptomatic but can include:

- Tingling
- Paraesthesia
- Muscle weakness
- Flaccid paralysis.

⇨ *Click here* **Potential precipitant causes**

⇨ *Click here* **Initial management**

Classification	Serum Potassium (mmol/L)
Mild	5.5 to 5.9
Moderate	6.0 to 6.4
Severe	≥ 6.5 or ECG changes at any potassium level >5.5
Teams will be contacted by Lab at 6.5mmol/L	

Precipitant causes

Excessive intake
Decreased excretion
Potassium shift to extracellular space

Also consider: **Pseudohyperkalaemia**

e.g. prolonged tourniquet time / fist clenching; tube sample haemolysis; EDTA contamination; leucocytosis; thrombocythemia.

- Do not delay treatment but re-check potassium urgently if an isolated or unexpected hyperkalaemia.
  - Send paired plasma (heparin) and serum (clotted) samples

Potassium movement out of cells, *e.g.*
Ketoacidosis, Mineralocorticoid deficiency such as primary Addison's disease

Decreased intake *e.g.* Acute Kidney Injury, Chronic Kidney disease, Hyperkalaemia renal tubular acidosis (IV)

Drugs (particularly when used in combination or if co-existing renal impairment)

Stop causative drug(s) if possible.

Common	Angiotensin Converting Enzyme inhibitors / Angiotensin II receptor antagonists. Consider further diuretic treatment if cannot be stopped in heart failure		
Amiloride	Spironolactone	Potassium supplements - IV or oral	
Less common- incl.	Heparin	Eplerenone	Triamterene
Non Steriodals *(NSAID)*	Trimethoprim	Succinylcholine	Beta-Blockers
Ciclosporin,	Tacrolimus	Cinacalcet	Nifedipine
Palonosetron	Arginine	Aliskiren	Potassium citrate
laxatives (eg Klean-prep, Movicol, fybogel)		Z|lendronic acid	Pentamidine

Note: If possible also stop beta-blockers and digoxin as they prevent intracellular buffering of potassium[2]

For further information on potential drug causes, contact: Medicines Information ext 23409

Note: Patients being treated with Digoxin	Digoxin toxicity should always be suspected in a patient taking digoxin. Seek senior advice on appropriate management, check for acute renal impairment.

⇨Click here to go to: **Initial management**

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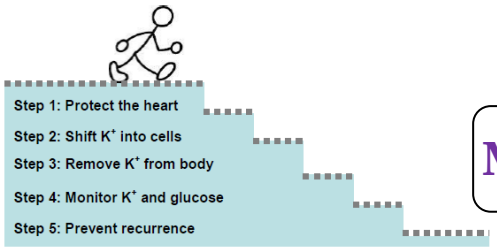
Initial Management



Mild S.K⁺ 5-5-5.9

Moderate S.K⁺ 6.0-6.4

Severe S.K⁺ Above 6.4

Consider

- Stop potassium supplements and drugs inhibiting potassium excretion.
- Avoid high potassium foods and salt substitutes. Low potassium diet. ⓘ

These measures may be sufficient in mild hyperkalaemia. Review to prevent recurrence.

If ECG changes

30ml Calcium gluconate **10% IV** (2-5 min bolus)[7] ⓘ

If QRS complex remains widened after 5-10 min - give a further 10ml every 10 min to a maximum of 50ml until ECG normalises

Also adopt general potassium reducing measures

10 units soluble insulin added to **50ml of 50% glucose** (25g) as a single IV dose over 5 minutes. Reduces serum K+ levels within 15 minutes and reaches maximum effect at 60 minutes - **Repeat if necessary**

If S. Glucose ≥ 15mmol/L - use insulin alone ⓘ

If needed: Salbutamol **10mg** via nebuliser ⓘ

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Next: Removal of potassium

Monitoring: U&Es/Glucose at 30min, 1,2,4 and 6 hours after each insulin/glucose. ⓘ
If hypoglycaemia consider 10% glucose at 50-75 mL/hr.
Watch for rebound hyperkalaemia after several hours

Outline flowchart: **Removal of potassium from the body**

Mild $S.K^+$ 5-5-5.9

Moderate $S.K^+$ 6.0-6.4

1st line

Calcium Zirconum Cryosilicate
Orally: 10g three or four times a day

Severe $S.K^+$ Above 6.4

If first-line agents have been unsuccessful, or if there is ongoing tissue damage and continued release of intracellular potassium is expected

Seek expert advice from General Intensive Care Unit

Patient monitoring

Test / Time - After start of insulin / glucose infusion							
Time	**0**	**30min**	**1hr**	**2hr**	**4hr**	**6hr**	**24hr**
Potassium	✓		✓	✓	✓	✓	✓
Glucose		✓	✓	✓	✓	✓	

Note: **Delayed hypoglycaemia** (Glu < 2.8mmol/L) is commonly reported when less than 30g of glucose is administered with insulin [1]. This can be delayed by several hours. Delays of 6+ hours have been seen, particularly with renal impairment.
10% glucose at 50mL/hr for 5 hours has been recommended following the insulin/glucose infusion[7]. Watch for rebound hyperkalaemia after several hours.

Further monitoring:
- Daily serum potassium until stabilised.
- Continuous ECG monitoring until potassium level returns to normal.
- Serum calcium or serum sodium as resin type dictates.

⇨Click here to go to: **Initial management**

Calcium and cardiac stabilisation: Detailed information

When to give calcium:

- Perform an ECG and attach a cardiac monitor.
- Life-threatening ECG changes - absent P waves, wide QRS, sine-wave pattern, presence of arrhythmias or cardiac arrest. - give calcium to stabilise cardiac membrane. Also consider if isolated peaked T waves [2].
- Calcium antagonises the toxic effects of hyperkalaemia even in the presence of a normal serum calcium.
- Evidence of effectiveness is limited [3,2]

Dosage and administration:

- 10ml Calcium gluconate 10% (2.2mmol) by IV bolus over 2-5 minutes. If the QRS complex remains widened after 5-10 minutes repeat 10ml every 10 min to a maximum of 30 to 50ml.[1].
  - Should be given through a central vein , PICC or large peripheral vein if possible as calcium is highly irritant & can cause necrosis on extravasation. Serum Osmolarity **726** mOsmol/L if neat, 346 if 10ml is diluted to 100ml.
  - Other potential adverse effects are peripheral vasodilation, hypotension, bradycardia, syncope and arrhythmias [2]

Alternate: Calcium chloride 10% (10ml = 6.8mmol) can be used instead but is more irritant.

- Serum Osmolarity = **2040** mOsmol/L if neat.
- **CARE** – Three times the calcium content of Gluconate so less may be required.

If also taking digoxin administer calcium over 30 minutes in 100ml 5% dextrose, to prevent myocardial digoxin toxicity. Seek senior opinion for urgent dialysis and administration of digoxin antibody fragments [1].

Onset and duration of action:

- Onset of action is within 1-5 minutes and the effect of a bolus dose lasts approximately 30-60 minutes [2].

Monitoring:

- ECG monitoring of response should be performed as calcium can cause adverse cardiac effects itself.
- A response may be seen with a narrowing of the QRS complex, reduction in T wave amplitude, increase in heart rate in bradycardic patients or reversal of arrhythmia.

External information:

Calcium Gluconate (Hameln) <Link to SPC> Calcium Chloride (Martindale) <Link to SPC>

Insulin and glucose: Detailed information

General information and mode of action:

• Insulin promotes intracellular potassium uptake by stimulating the Na/K pump. This will not remove excess potassium from the body. Note: Efficacy of insulin/glucose has mainly been demonstrated in ESRD patients.
• Care - There is evidence that insulin/glucose + nebulised salbutamol have additive effects in lowering potassium, with a weakening of the hypoglycaemic action of insulin [1].

Dosage and administration:

• 10 units soluble insulin added to 50ml of 50% glucose (=25g) by intravenous infusion as a single dose over 5 to 15 minutes.[1].
• Consider 5 units soluble insulin in end stage renal disease to recue hypoglycaemia risk [5]
• A regimen of 10 units in 500ml 5% dextrose (25g) over 60 minutes – followed by 10% glucose at 50-75 units per hour has been advocated to reduce the risk of hypoglycaemia(UpToDate).
***NB**: 50% glucose has an osmolarity of 2775 mOsmol/L so is highly irritant.*
  • Administer via a large vein, monitor for extravasation / phlebitis.
  • Administer over 30 to 60 minutes if too irritant, small vein etc
• Repeat a single dose of 10 units soluble insulin added to 50ml of 50% glucose IV if necessary.

Onset and duration of action:

• Onset usually with in 10-20 min, peaks at 30-60 mins. With a peak potassium reduction of around 0.6-1mmol/l.[1,2,3, 2]
• Potassium reduction usually lasts around 2 hr, often followed by a rebound increase.
Treatment aim is potassium less than <6 within 2hr[2].
• Care - Glucose lasts 4 hours or less = risk of hypoglycaemia (which can be delayed up to 6 hr in renal failure[2])

Monitoring: See page 5 – Risk of hypoglycaemia

• Serum glucose: If greater than or equal to 15mmol/L - use insulin alone.[2]

Salbutamol: Detailed information

General information and mode of action:

- Has an additive effect with insulin dextrose to promote the intracellular shift of potassium whilst weakening the hypoglycaemic action of insulin [1]
- The hypokalaemic response is attenuated if taking β-blockers or digoxin or in dialysis patients [6]
- May not be effective in all patients – not recommended as a single agent [4]
- Drops potassium by 0.5-1mmol/L [1,2]

Dosage and administration:

- Usual dose = 10mg via nebuliser
  - 20mg has been used with greater effect at 2 hours[3,2] (but no more than 10mg per dose should be given if ischaemic heart disease).[1,2,3]
  - Some, limited evidence that IV salbutamol (500mcg) has a greater potassium decrease than nebulised, but at a higher risk of side-effects [3].

Onset and duration of action:

- Onset within 20-30 minutes, peak effect 10mg at 2 hours.[3,6] / 20mg at 90 minutes [3]

Monitoring:

- May cause tachycardia, headaches, dizziness [3].
- Monitor carefully for beta-adrenergic stimulation.

Calcium Zirconum Cryosilicate: Detailed information

General information and mode of action:

• Sodium Zirconium Cyclosilicate (SZC) is a non-absorbed potassium binder that preferentially exchanges H+ and Na+ for K+ and ammonium ions throughout the entire gastrointestinal tract (Ref 8)

•Most studies were in the stable out-patient setting but use was agreed by NICE for use on acute l;ife-threatening hyperkalaemia alongside standard care.

•Most pateints in a subgroup analysis from one study achieved a serum potassium between 4 and 6 after treatment at a S.Potasisum level above 6.

•Dosage and administration:

• SZC 10g three times a day for up to 72 hours (correction phase), but if hyperkalaemia is not controlled by this time, it should be discontinued (Ref 8)

Ion-exchange resins: Detailed information

There is little evidence of efficacy in acute treatment, so first line use is not recommended.

General information and mode of action:

- Ion exchange resin for permanent potassium removal in mild to moderate hyperkalaemia. There is no place for exchange resins in severe hyperkalaemia.
- Faecal obstruction and necrosis is possible. The resins are contra-indicated in obstruction.

Dosage and administration:

- 15g three or four times a day.
    - May be given in a little water (approx. 50ml) or made into a paste with jam or honey (Avoid fruit juices/squash as they may contain potassium).
- Laxatives must be co-prescribed. Avoid magnesium & aluminium-containing laxatives.
- May reduce Lithium & Levothyroxine absorption.
- Give for at least 24 hours, check serum potassium, review daily. Up to 5 days may be required.
- Stop the resin when the serum potassium reaches 5 mmol/L to avoid hypokalaemia.
- Irrigate the colon after resin is stopped to remove any remaining.
- Rectal should only be considered if the oral route is unavailable. Do not use if obstructive bowel disease. See Calcium Resonium® or Resonium A® SPCs for dosing and administration instructions.
- Less effective than oral administration, as each enema should be retained for 9 hours for maximum effect.

Key References

(1) GAIN guidelines for the treatment of hyperkalaemia in adults. Northern Ireland Guidelines Network. Aug 2014. <Link>

(2) Clinical practice guidelines for treatment of acute hyperkalaemia in adults . UK Renal Association. 2014. <Link>

(3) Pharmacological interventions for the acute management of hyperkalaemia in adults. Cochrane Library, 2015. <Link>

(4) Combination use of medicines from different classes of renin-angiotensin system blocking agents: risk of hyperkalaemia and impaired renal function. Drug Safety Update v7 Iss 11. Aug 2014. MRHA. <Link>

(5) Treatment of Hyperkalemia With a Low-Dose Insulin Protocol Is Effective and Results in Reduced Hypoglycemia. Kidney Int Rep (2018) 3, 328–336. <Link>

(6) Treatment and prevention of hyperkalemia in adults. Up To Date 2017 [accessed 29.3.19]

(7) National Patient Safety Alert. NatPSA/2023/007/MHRA. 27 Jun 2023.

(8) Clinical Practice Guidelines. Treatment of acute hyperkalaemia in Adults. The Renal Association. June 2020.

Further reading:

Resources to support safe and timely management of hyperkalaemia. NHS Improvement. Patient Safety Alert. 8 Aug 2018. <Link>

NHS Improvement Hyperkalaemia video < Link>

Potassium monograph. Association of Clinical Biochemistry. 2013. <Link>

Treatment algorithm – Renal Association 2014 <Link>

Further information – Diet:

High potassium-containing foods : *Include*

• Fruit juice, fruit squash, fruits, chocolate, biscuits, fruit gums, coffee & potatoes.

• Patients with moderate to severe disease should be referred to a dietitian. Ongoing dietary modification may be necessary.

• The Renal Association has a patient information leaflet for general advice but please note this is tailored to hyperkalaemia secondary to renal impairment. <Link>

Intended Patients	Adult patients
Intended Users	Medical, nursing and pharmacy staff

Development Group

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