MIL

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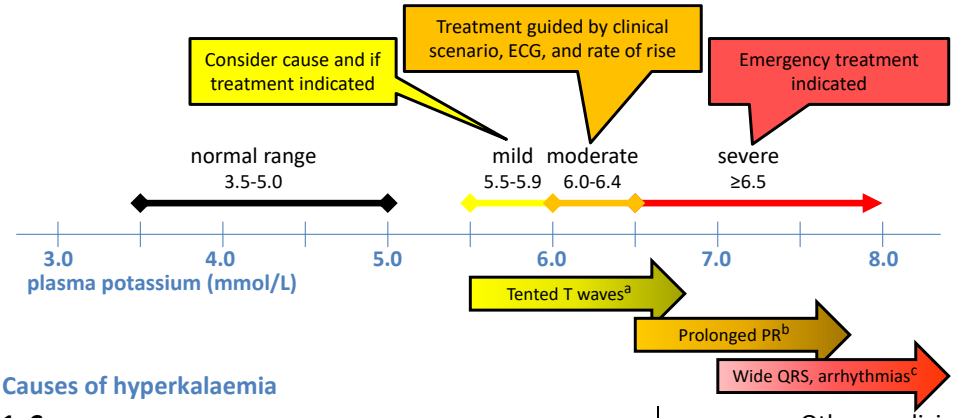
This Medicines Information Leaflet is produced locally to optimise the use of medicines by encouraging prescribing that is safe, clinically appropriate and cost-effective to the NHS.

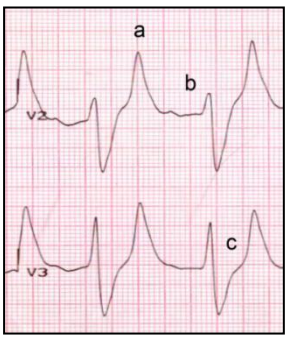
Guidelines for the Management of Hyperkalaemia in Adults

Hyperkalaemia is defined as a plasma potassium (K^+) **level greater than 5.5 mmol/L (normal adult range 3.5 – 5.0).**
Potassium is primarily an intracellular cation, with approximately 2% of total body potassium in the extracellular fluid. It is essential for numerous metabolic and physiological processes including nerve conduction, muscle contraction and acid–base regulation. Potassium is primarily excreted by the kidneys.

Hyperkalaemia has been reported to occur in about 2-5% of hospitalised patients, frequently in patients with comorbidities [chronic kidney disease (CKD), diabetes mellitus, congestive cardiac failure]. Medicines are usually implicated. Often there is concomitant acute kidney injury (AKI).

Severe acute hyperkalaemia can be life-threatening so prompt and effective management is essential. Equally treatments for acute hyperkalaemia can have adverse effects and the risks of treatment should be weighed against the benefits. Chronic hyperkalaemia may be less dangerous than acute hyperkalaemia, particularly in patients with advanced CKD. If there is uncertainty as to whether the hyperkalaemia is real (rather than pseudohyperkalaemia), it is often safer to treat while repeat bloods are being processed.





Characteristic ECG of severe hyperkalaemia

Causes of hyperkalaemia

1. Common causes:

- AKI (often stage 3)
- Any metabolic acidosis
- CKD – either advanced CKD alone or milder CKD plus another cause(s) (e.g. AKI, diet, etc.)

2. Commonly implicated medicines:

- Angiotensin-converting enzyme (ACE) inhibitors/Angiotensin receptor blockers (ARB)
- Potassium replacement medications
- Potassium-sparing diuretics (e.g. spironolactone, eplerenone, amiloride)
- Trimethoprim (including Co-trimoxazole)
- Non-steroidal anti-inflammatory drugs

3. Other causes to consider:

- Dead tissue (e.g. rhabdomyolysis, burns) – NB potassium may be persistently raised
- Addison's disease
- Other medicines (beta-blockers, digoxin [at toxic levels], heparins, macrogol-containing laxatives, ciclosporin)
- Dietary intake (in advanced CKD)
- Type IV renal tubular acidosis
- GI haemorrhage (in advanced CKD)
- Multiple units of packed red cells (very rare)
- Haemolytic anaemia (very rare)

4. Pseudohyperkalaemia occurs when the potassium result is not true reflection of the actual plasma potassium, but is artificially raised. This may be due to:

- Prolonged tourniquet time
- Haemolysed sample (incl. delayed processing)
- Drip arm sample (i.e. taken from a limb infused with IV fluids containing potassium)
- Marked thrombocytosis or leukocytosis

Emergency Management of Hyperkalaemia

Potassium 5.5 mmol/L or greater

Pseudo

True

ABCDE approach; 12 lead ECG; take VBG, lab U&E, blood glucose

Mild (K^+ 5.5-5.9)

If chronic/stable no Rx indicated. If rapidly rising consider Rx

Moderate (K^+ 6.0-6.4)

Any adverse features: rapidly rising K^+? ECG changes?

If no adverse features, use clinical judgement to decide if benefit of Insulin and Glucose 50% outweighs 15% risk of hypoglycaemia

Severe (K^+ 6.5 or more)

Seek urgent help if K^+ 7.0 or greater

SEEK URGENT HELP IF:

- K^+ is 7.0 mmol/L or greater
- Patient usually has dialysis
- CKD stage 5 / AKI stage III

Bleeps: Renal SpR 5924 or via switch; JR AICU SpR 1418; JR med SpR 1475; Horton med SpR 9509.

Main dialysis unit ext 25807; Tarver dialysis unit ext 25725.

If adverse features, treat as severe

1 Immediate Rx (protect heart):
6.8 mmol IV calcium
Ideally cardiac ECG monitoring
30mL 10% calcium gluconate into large vein and flush well.
Repeat ECG after 5-10 mins and repeat dose if ECG changes persist

2 Acute Rx within 1 hr (shift K^+ into cells):
Insulin & Glucose 50% IV infusion
If blood glucose (BG) 10 mmol/L or greater, Actrapid® Insulin 10 units in 50mL of 50% Glucose over 10 mins

If pre-infusion BG below 10 mmol/L:

- Below 4.0: treat hypoglycaemia with 75mL **20%** glucose IV then repeat BG and give Insulin & Glucose **50%** (dose of Insulin depending on repeat BG)
- BG 4.0-5.9: use 4 units Actrapid® Insulin
- BG 6.0-7.9: use 6 units Actrapid® Insulin
- BG 8.0-9.9: use 8 units Actrapid® Insulin

} with 50mL of 50% Glucose

ALWAYS DRAW UP INSULIN WITH AN INSULIN SYRINGE
(repeat dose after 2-4 hours if needed)

3 Adjunctive therapy
Consider with Insulin & Glucose 50%: **Nebulised Salbutamol**
Give 10mg over 10 mins (can be repeated once). **Caution if at risk of tachyarrhythmia.**

Check blood glucose hourly for 6 hours post-Insulin & Glucose 50% infusion (more frequently if BG falling towards 4.0 mmol/L or clinical suspicion of low blood glucose)

4 MODERATE & SEVERE HYPERKALAEMIA
OR MILD HYPERKALAEMIA WITH RAPIDLY RISING K^+:

- **Suspend nephrotoxic / K^+ containing medicines**
- **Review diet** if advanced CKD (chocolate, certain fresh fruit/fruit juices).
- **Hydrate and treat hypotension** to promote urinary K^+ excretion (consider loop diuretic if well hydrated)
- **Daily U&E** and treat underlying cause of hyperkalaemia.

5 MODERATE & SEVERE HYPERKALAEMIA
Seek specialist/renal advice to consider:

- **Cation-binder** i.e. Sodium Zirconium Cyclosilicate (SZC, Lokelma®) and/or **Sodium Bicarbonate** (oral or IV)
- **Acute dialysis** if K^+ 6.5 or greater for at least 4 hours despite interventions or underlying cause not rapidly reversed. It is better to prevent severe hyperkalaemia with timely dialysis, rather than asking for this as an emergency.

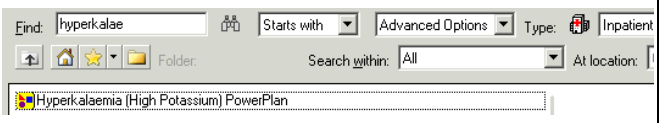
Repeat blood gas at 2 & 6 hours

Repeat cycle until K^+ persistently below 6.5 – frequently rebounds after acute Rx worn off (i.e. 2-4 hours)

Pharmaceutical Management and Prescribing Advice

Refer to the flow chart for a quick summary of the management plan. To prescribe, search for the

Hyperkalaemia (High Potassium) Powerplan under 'Requests & Prescribing' on EPR and select an appropriate treatment plan.



1. Intravenous calcium

- For severe hyperkalaemia or moderate hyperkalaemia with ECG changes/with rapid rise/as guided by clinical scenario (subtle ECG abnormalities often overlooked, so use in severe hyperkalaemia usually outweighs risks).
- Give via a large vein as IV calcium salts are very irritant. Continuous ECG monitoring is advised (but do not delay treatment whilst establishing cardiac monitoring).
- **IV calcium gluconate 10% ampoules** are stock on most hospital wards. 10mL contains 2.26mmol of calcium; 30mL contains 6.8mmol of calcium.
- **IV calcium chloride 10% ampoules** are only stock on critical care wards and in black emergency boxes. 10mL contains 6.8mmol of calcium (i.e. 3 times as much as for calcium gluconate).
- Do not mix with other IV agents (precipitation risk).
- Do not give if patient has adjusted calcium over 3.0 mmol/L or patient has digoxin toxicity.
- Give dose undiluted over 5-10 minutes.
- If the patient is on **digoxin**, dilute dose with 100mL of sodium chloride 0.9% or glucose 5% and give as a 20 minute infusion, as rapid administration can precipitate myocardial digoxin toxicity.
- Repeat doses can be given after 5-10 minutes if ECG changes persist.

Onset of action: 1-3 minutes
Duration of action: 30-60 minutes
Mode of action: Stabilises the myocardial membrane, has no effect on potassium level.

2. Insulin-glucose 50% intravenous infusion

- Use if giving intravenous calcium; consider if moderate hyperkalaemia without adverse features based on clinical scenario.
- Give via a large vein as glucose 50% is very irritant.
- Do not source glucose from Hypobox (which is **20%** concentration rather than 50%).
- Regular blood glucose monitoring is required, as risk of hypoglycaemia is approx. 15%.
- Dose of insulin depends on blood glucose, so check within 1 hour of starting infusion:
- If blood glucose 10 mmol/L or greater, give 10 units of Actrapid® insulin in 50mL of glucose 50% over 10 minutes.
- Reduce dose of insulin if pre-infusion blood glucose is below 10 mmol/L:

Pre infusion blood glucose (mmol/L)	Actrapid® Insulin dose (to be administered with 50mL of 50% glucose)
Below 4.0	Rx hypoglycaemia with **20%** glucose 75mL intravenously, then recheck glucose at 15 minutes to confirm hypoglycaemia corrected before giving insulin and glucose **50%** infusion (dose of insulin depending on blood glucose)
4.0-5.9	4 units Actrapid® insulin
6.0-7.9	6 units Actrapid® insulin
8.0-9.9	8 units Actrapid® insulin
10-20	10 units Actrapid® insulin

- If blood glucose 20 mmol/L or greater, check ketones and follow DKA or HHS MIL if appropriate. If not, seek advice and consider giving Actrapid® insulin without glucose 50%.
- **Always use an insulin syringe to measure the dose of insulin (it is calibrated in units).**
- It is mandatory to get your insulin dose independently checked and countersigned on the drug chart by another qualified member of staff.
- Ensure product is thoroughly mixed.
- Please see final page for pictorial guide to preparing insulin-glucose 50% infusion.
- **Check blood glucose hourly for 6 hours after insulin-glucose 50% infusion, and more frequently if falling towards 4.0 mmol/L or clinical suspicion of low blood glucose.**
- Insulin-glucose 50% infusion can be repeated after 2-4 hours if hyperkalaemia remains severe (K^+ above 6.5 mmol/L). Should recheck K^+ with VBG at 2 and 6 hours.

Onset of action: 15-60 minutes
Duration of action: 6 hours
Mode of action: Shifts potassium into the cells.

3. Nebulised Salbutamol

- Can be used an adjunct to insulin-glucose 50% infusion (salbutamol should not be used as monotherapy).
- Give 10mg over 10 minutes via nebuliser.
- Caution in patients with ischaemic heart disease (maximum dose 10mg), previous history of arrhythmias, or open angle glaucoma. Cardiac monitoring is advised.
- Less effective if patient taking beta-blockers, digoxin or on chronic dialysis.
- Dose can be repeated once (i.e. maximum of 20mg).

Onset of action: 30-60 minutes
Duration of action: 4-6 hours
Mode of action: Shifts potassium into cells.

4. Cation-binding medications

- **Sodium Zirconium Cyclosilicate (SZC, Lokelma®)** is preferred to Calcium polystyrene sulfonate (brand: Calcium Resonium®) as it is more efficacious and better tolerated. SZC is licensed for use in chronic hyperkalaemia of CKD and may have a role in emergency management of acute hyperkalaemia.
- SZC must only be initiated following documented specialist renal advice. It should be reviewed after 3 days and at 1 week, explicitly to consider if chronic use is indicated.
- **Oral**: Give 10g BD or TDS in 50mL water for 3 days then 5g-10g daily
- Monitor for peripheral oedema and constipation.

Onset of action: 1-2 hours
Duration of action: 12-24 hours
Mode of action: Removes potassium via the gut.

5. Sodium bicarbonate

- May ameliorate acidosis but can contribute to fluid retention, hypernatraemia and hypertension.
- There is insufficient evidence to support its routine use, and certainly not as monotherapy.
- Can be initiated following specialist advice (e.g. from general medical, renal or ICU registrar or consultant).
- Do not give intravenously together with IV calcium due to risk of precipitation.
- (Separately, 8.4% sodium bicarbonate IV can be used in resuscitation after cardiac arrest.)
- **IV:** Give 500mL of 1.26% Polyfusor over 4-6 hours.
- **Oral**: Give 500mg-1g TDS.

Onset of action: Over 60 mins (IV); 24 hours (PO)
Duration of action: variable
Mode of action: Correction of acidosis.

Additional Notes on licensing

Insulin and Glucose 50% intravenous infusion and Nebulised Salbutamol, although key components of these guidelines, are not formally licensed for management of hyperkalaemia in UK. Likewise Sodium Bicarbonate is licensed for amelioration of acidosis rather than hyperkalaemia (although by doing so, potassium is generally reduced).

References

- The Clinical Practice Guidelines for the Treatment of Acute Hyperkalaemia in Adults (2020). UK Renal Association.
- Guidelines for the Treatment of Hyperkalaemia in Adults (2014). Guidelines & Audit Implementation Network (GAIN).
- Oxford Textbook of Clinical Nephrology, 3rd Ed (2008), Vol 1

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How to prepare insulin and glucose for hyperkalaemia

Pat Warriner, Medicines Safety, V5, Nov 2021

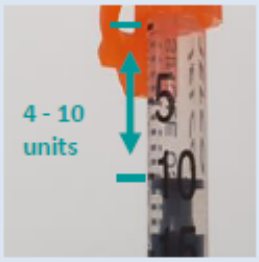
1. Prepare equipment

Review prescription
Perform PPID, explain & discuss with patient/carer
Prepare injectable label for 50mL syringe
Clean blue tray
Collect items required:

- Insulin safety syringe
- Actrapid insulin vial
- Administration set
- 2 x Chlorhexidine 2% in alcohol 70% wipes
- 50mL syringe
- Glucose 50% vial

Remove tamper evident seal from Actrapid and glucose vials
Wipe rubber septum of each vial with chlorhexidine/alcohol wipes. Allow to dry for 30 seconds.

2. Add Actrapid® according to blood glucose



Recheck BG if last reading is over an hour before preparing the infusion

Remove the needle cover from an insulin syringe.
Insert the needle into the Actrapid insulin vial through the rubber septum.
Invert the vial and pull back the plunger gently until you have measured out the correct number of units. This is based on the patients blood glucose (BG):

BG 4.0-5.9 use 4 unit Actrapid® Insulin
BG 6.0-7.9 use 6 unit Actrapid® Insulin
BG 8.0-9.9 use 8 units Actrapid® Insulin
BG over 10 use 10 units Actrapid® Insulin

Check the insulin dose with a second practitioner.

3. Add Actrapid insulin to glucose

Inject the required number of units of Actrapid insulin into the glucose 50% vial.
Gently swirl the vial to ensure the Actrapid insulin is mixed.
Discard the insulin syringe.

4. Withdraw contents into a 50 mL syringe

Using a 50 mL syringe with a sheathed, blunt fill needle attached, draw back the syringe to 50 mL. Remove the sheath and inject the needle into the vial containing the glucose and Actrapid insulin.
Repeatedly inject small volumes of air with the needle in the solution using the push pull technique.
Draw up equal volumes of solution by releasing the plunger so the solution flows back into the syringe and continue until 50 mL in syringe.
With the needle and the vial upper-most, tap the syringe lightly to aggregate the air bubbles at the needle end.
Push the air back into the vial and then withdraw the needle from the vial.

5. Set up the infusion pump

Remove the needle and discard. Attach the administration line to the syringe.
Purge the line until a drop of solution is at the end of the line.
Attach the injectable label to the syringe and label the line.
Set pump to administer the 50mL over 10 minutes.
Monitor BG hourly for 6 hours.