SPRUN

SCOTTISH PAEDIATRIC RENAL AND UROLOGY NETWORK

Hyperkalaemia Guideline

NOTE

This guideline is not intended to be construed or to serve as a standard of care. Standards of care are determined based on all clinical data available for an individual case and are subject to change as scientific knowledge and technology advance and patterns of care evolve. Adherence to guideline recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan. This judgement should only be arrived at following discussion of the options with the patient, covering the diagnostic and treatment choices available. It is advised, however, that significant departures from the national guideline or any local guidelines derived from it should be fully documented in the patient's case notes at the time the relevant decision is taken.

This guidance has been prepared by NHS National Services Scotland (NSS) National Networks. Accountable to Scottish Government, NSS works at the heart of the health service providing national strategic services to the rest of NHS Scotland and other public sector organisations to help them deliver their services more efficiently and effectively. Working across professional and organisational boundaries, National Networks support the delivery of safe, effective healthcare that's designed around patients, carers and families.

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Pharmacy Review	Angela Lamb, Renal Pharmacist
Stakeholders involved	Consultant Paediatric Nephrologists Consultant Paediatricians w/ Nephrology Special Interest Paediatric Nephrology Specialist Pharmacist Paediatric Nephrology Specialist Trainees Paediatric Nephrology Advanced Nurse Practitioner
Methodology used	Review of hyperkalaemia guidelines used in other units nationally and internationally, reviewing current established practice along with available literature evidence for hyperkalaemia management options.
Rationale	The network was established to support and develop Nephrology services throughout Scotland in improving standards of clinical care for patients. The network supports the delivery of evidence based, patient centred care through the development and implementation of clinical guidelines, care pathways and information resources utilising a once for Scotland approach. There is a variance in hyperkalaemia management between led by primarily intensivists or nephrologists. As hyperkalamia outwith intensive care setting is more common, it was felt vital to ensure consistence guidance on management in the non-intensive clinical setting, as led by nephrology in our wider SPRUN network, in keeping with national nephrology practice.
Scope	Paediatric Nephrologists and General Paediatricians managing children with acute hyperkalaemia in Scotland
Approval process	The guideline was approved by the SPRUN Steering Group on 11 June 2025. Membership available in Appendix 2.

Contents

1. Hyperkalaemia – management in infants and children

Hyperkalaemia is commonly encountered in paediatrics. Severe hyperkalaemia can be life-threatening and requires emergency treatment. Neonates and infants (<6 months old) tend to tolerate hyperkalaemia better than older children and adolescents, with higher levels tolerated before ECG changes become apparent.

Mild hyperkalaemia (5.5-6 mmol/L) – review the patient, assess possible causes and adjust their current management as needed.

Hyperkalaemia can cause life-threatening arrhythmia – an ECG is crucial to determine the clinical significance and extent of further management.

Please see the separate neonatal guideline for management of hyperkalaemia within neonatal units (https://clinicalguidelines.scot.nhs.uk/ggc-paediatric-guidelines/ggc-paediatric-guidelines/neonatology/hyperkalaemia-a-guideline-for-management-in-neonates).

2. Medical management

Management is summarised in the flow-chart (see below). Medication dosing, unless specified within this guideline, should follow BNFc and/or local hospital policy.

Generally, before any treatment, the potassium result should be confirmed with a repeat venous sample and a gas for point-of-care testing. However, if K >6.5 mmol/L and plausible given the current clinical scenario, further investigation and treatment should be instigated BEFORE the repeat result is available.

Treatment focuses on:

1 – Stabilise myocardium to reduce risk of arrhythmias

2 – Acutely reduce serum potassium level by:

- Shifting potassium intracellularly (temporary)
- Removing from the body

3 – Address the underlying cause of hyperkalaemia including limiting intake and optimising potassium excretion

Where K>6.5 mmol/L and confirmed on repeat, early discussion with the Paediatric Nephrology team (via Royal Hospital for Children, Glasgow switchboard) is recommended to guide management, investigation, and consideration of transfer/use of renal replacement therapy in refractory cases.

3. Further investigations

- ECG (including starting ECG monitoring) – ECG changes in keeping with hyperkalaemia, in order of occurrence with sequentially increasing potassium levels, are:
    - Tall or “tented” T-Waves (this is the earliest sign of conduction disturbance caused by hyperkalaemia)
    - Prolonged PR
    - Flattening or missing P wave
    - Broad QRS
    - Bradyarrhythmias
    - In severe hyperkalaemia – sine wave appearance of ECG, VT/VF, PEA or asystole
- Urine electrolytes –useful to assess for both renal and non-renal causes
- Further blood samples depend on the clinical scenario and can be obtained after treatment.

4. Treatments

Calcium Gluconate:

- Calcium stabilises the myocardium and reduces the risk of arrhythmia
- This **DOES NOT remove potassium**
- Dosing:
    - Calcium Gluconate 10%, give 0.5mL/kg (max 30mL) over 5-10mins
        - 0.5mL = 0.11mmol of the 10% injection
    - Given via slow IV injection (2-5 minutes)
    - Requires **continuous ECG monitoring** – watching specifically for bradycardia, if bradycardia develops then STOP infusion
- Contra-indications:
    - Cannot be given simultaneously with Sodium Bicarbonate
    - Contra-indicated if hyperkalaemia or ECG abnormalities are secondary to Digoxin toxicity

Salbutamol

- **Does not remove potassium** from the body – causes intracellular shift of potassium.
- Given via nebuliser:
    - Age <5 years – 2.5mg x 3 doses, then repeated every 3-4 hours
    - Age >5 years – 5mg x 3 doses, then repeated every 3-4 hours
- Predominant side-effects – tachycardia, jitteriness, lactic acidosis.

Sodium Bicarbonate

- **Does not primarily remove potassium** from the body –it promotes intracellular shift of potassium (note – however, improving metabolic acidosis can increase renal potassium excretion- so potential dual action)
- Indicated if serum bicarbonate <20 mmol/L
- Ensure ionised calcium is normal before giving bicarbonate – otherwise calcium will bind with albumin, reducing the ionised calcium and potentially causing hypocalcaemia
- Dose:
    - 1mmol/kg (1mL/kg of 8.4% Sodium Bicarbonate)
        - Dilute to 1:10 with 0.9% Sodium Chloride, can be given more concentrated in a fluid restricted patient if necessary
            - If giving concentrated bicarbonate – ensure large bore, reliable venous access and be vigilant for extravasation injuries
        - Give over 15-30 minutes
        - If diluted 1:10, the additional volume means this essentially doubles as a 10mL/kg fluid bolus
    - Dose can be repeated if necessary, depending on serum bicarbonate level.

Furosemide

- Removes potassium from the body.
- Loop diuretic, directly inhibits potassium resorption.
- In patients with normal renal function, it is a very potent diuretic.
    - If significant response to furosemide, IV fluid boluses may be necessary to ensure adequately intravascularly filled.
- Dosing:
    - 1mg/kg, max dose 60mg
    - Can be repeated every 4-6 hours if necessary

- Cautions:
    - Patients with underlying renal disease - discuss with Paediatric Nephrology consultant on call
    - Patients who are clinically dehydrated at presentation, with Acute Kidney Injury (AKI) – use other measures first line and consider furosemide following fluid resuscitation
    - Patients with other electrolyte abnormalities at presentation (namely hypo/hypernatraemia)

Insulin/Dextrose:

- **INSULIN/DEXTROSE IS A HIGH RISK INFUSION DUE TO THE RISK OF DRUG ERRORS**. Insulin should only be given after discussion with the renal consultant on call and under exceptional circumstances, when all other treatment options have been unsuccessful and potassium remains dangerously elevated.
    - Do not give Insulin/Dextrose unless **refractory hyperkalaemia AND ECG changes** are present.
- **Does not remove potassium** from the body – shifts potassium intracellularly.
- Dose:
    - 2mL/kg of 50% dextrose, with 0.1 units/kg Actrapid mixed in the SAME SYRINGE
        - Given over 5-10 minutes
- Caution in:
    - Diabetic patients
    - Critically unwell patients with hypo- or hyperglycaemia
    - Patients <10kg – as insulin dose will be less than 1 unit, extreme caution to ensure correct insulin dose is added to the syringe
        - Round to nearest 0.5 units to ensure measurable volume given

Calcium Polystyrene Sulfate (also known as Calcium Resonium)

- Removes potassium from the body.
- Resorbs potassium from the gut wall – this will actively remove potassium from the body, although effect is relatively mild and slow.
    - Resonium is NOT an effective immediate treatment for acute, severe hyperkalaemia.
- Can be given either orally or rectally, or via nasogastric tube. If given via nasogastric tube (NGT), ensure flushed well to prevent blockage.

- Dose:
    - Oral: 0.5-1g/kg/day in divided doses (max 60g/day)
    - Rectal: 0.5-1g/kg/day in divided doses (max 30g/day)
    - For both oral and rectal routes, a practical starting dose is:
        - 0.25g/kg, max dose 15g, given 6 hourly
    - Onset of action is quicker rectally (1 hour) than orally (4-6 hours)
- Contra-indications and cautions:
    - Any concerns regarding gut integrity
        - Recent laparotomy, perforation, ileus, Necrotising Enterocolitis (NEC)
    - Premature infant (<36 weeks corrected) – risk of NEC if given enterally, avoid unless absolutely necessary and if deemed necessary, must be given rectally

Sodium Chloride 0.9%

- Removes potassium from the body.
- If dehydrated, rapid restoration of circulating volume may be sufficient to resolve hyperkalaemia (improving GFR and increasing renal potassium excretion).
- In non-dehydrated patients, when given in conjunction with Furosemide, can increase renal potassium excretion and improve hyperkalaemia.
- Dose:
    - 10mL/kg in dehydrated patients over 30-60 minutes
    - Review and repeat if clinically indicated
- Cautions:
    - Anuric patients
    - Patients with known cardiac disease or renal failure
    - Any patient on dialysis

Glucose:

- **Does not remove potassium** from the body – shifts potassium intracellularly.
- Mechanism of action - stimulating endogenous insulin secretion
- Dose:
    - 2.5mL/kg 10% glucose given over 2-5 minutes
    - If already on IV fluids, ensure adequate glucose is included:

      May be useful to increase to 10% glucose to further stimulate insulin.

5. References

Joint Formulary Committee (2024) British National Formulary for Children. Available at: https://www-medicinescomplete-com.apollo.worc.ac.uk/#/browse/bnfc (Accessed: April 2024).

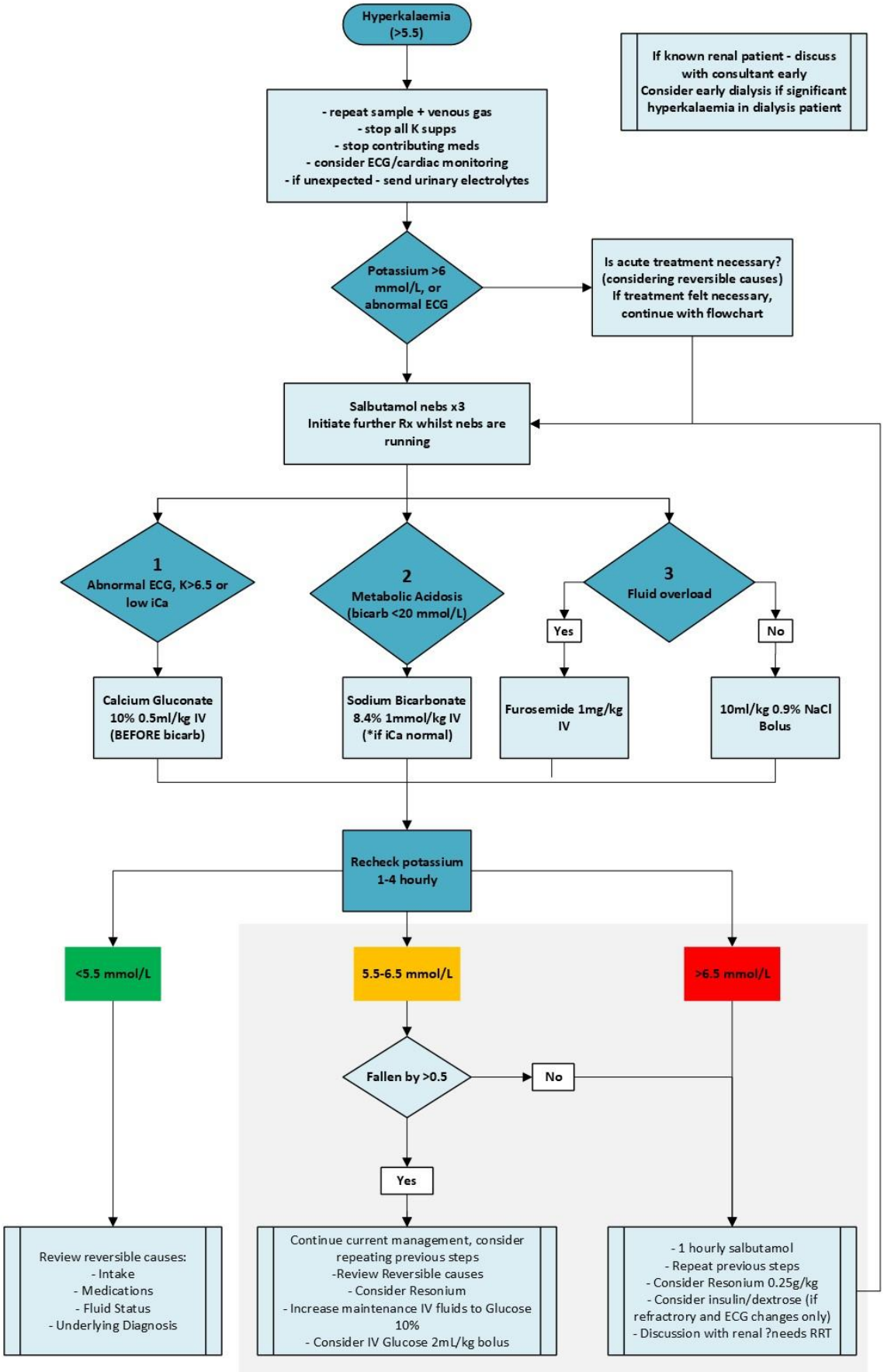
The Royal Children's Hospital Melbourne – Hyperkalaemia guideline https://www.rch.org.au/clinicalguide/guideline_index/hyperkalaemia/

Rubens M, Kanaris C. 15-minute consultation: Emergency Management of Children presenting with Hyperkalaemia Arch Dis Child Educ Pract Ed Epub ahead of print. doi:10.1136/ archdischild-2021-322080

Masilamani K, van der Voort J. The management of acute hyperkalaemia in neonates and children. Arch Dis Child 2012; 97:376.

Buttner R and Burns E. Hyperkalaemia ECG changes. Life in the fast lane. https://litfl.com/hyperkalaemia-ecg-library/

Appendix 1


Hyperkalaemia (>5.5)
If known renal patient - discuss with consultant early
Consider early dialysis if significant hyperkalaemia in dialysis patient
- repeat sample + venous gas
- stop all K supps
- stop contributing meds
- consider ECG/cardiac monitoring
- if unexpected - send urinary electrolytes
Potassium >6 mmol/L, or abnormal ECG
Is acute treatment necessary? (considering reversible causes) If treatment felt necessary, continue with flowchart
Salbutamol nebs x3
Initiate further Rx whilst nebs are running
1
Abnormal ECG, K>6.5 or low iCa
2
Metabolic Acidosis (bicarb <20 mmol/L)
3
Fluid overload
Yes
No
Calcium Gluconate 10% 0.5ml/kg IV (BEFORE bicarb)
Sodium Bicarbonate 8.4% 1mmol/kg IV (*if iCa normal)
Furosemide 1mg/kg IV
10ml/kg 0.9% NaCl Bolus
Recheck potassium 1-4 hourly
<5.5 mmol/L
5.5-6.5 mmol/L
>6.5 mmol/L
Fallen by >0.5
No
Yes
Review reversible causes:
- Intake
- Medications
- Fluid Status
- Underlying Diagnosis
Continue current management, consider repeating previous steps
-Review Reversible causes
- Consider Resonium
- Increase maintenance IV fluids to Glucose 10%
- Consider IV Glucose 2mL/kg bolus
- 1 hourly salbutamol
- Repeat previous steps
- Consider Resonium 0.25g/kg
- Consider insulin/dextrose (if refractrory and ECG changes only)
- Discussion with renal ?needs RRT

Appendix 2 – SPRUN Steering Group Membership

Name	Designation	Role	Area representing
Deepa Athavale	Consultant Paediatric Nephrologist	Lead Clinician/Chair	NHS Greater Glasgow & Clyde
Rozi Ardill	Consultant Paediatrician	Member	NHS Lothian
Susan Burns	Renal Data Manager	Member	NHS Greater Glasgow & Clyde
Claire Cowe	Renal Nurse Specialist	Member	NHS Grampian
Sheena Dunsmore	Trustee	Member	Third Sector (Kidney Kids Scotland)
Karen Elrick	Paediatric Renal Dietician	Member	NHS Greater Glasgow & Clyde
Fiona Graham	Paediatric Renal Dietician	Member	NHS Greater Glasgow & Clyde
Claire Haggerty	Renal Nurse Specialist	Member	NHS Greater Glasgow & Clyde
Liz Hunter	Consultant Clinical Psychologist	Member	NHS Greater Glasgow & Clyde
Angela Lamb	Paediatric Renal Pharmacist	Member	NHS Greater Glasgow & Clyde
Boma Lee	Consultant Surgeon / Urologist	Member	NHS Greater Glasgow & Clyde
Karen McFarlane	Manager	Member	Third Sector (Kidney Kids Scotland)
Ursula Monachan	Advanced Renal Nurse Practitioner	Member	NHS Greater Glasgow & Clyde
Robin Oswald	Consultant Paediatrician	Member	NHS Tayside
Peter Schulga	Consultant Paediatric Nephrologist	Member	NHS Greater Glasgow & Clyde
Jan Vedarajan	Specialty Doctor/ Link Paediatrician	Member	NHS Highland