Part of the Sydney Children's Hospitals Network

HYPERKALAEMIA

PRACTICE GUIDELINE ©

DOCUMENT SUMMARY/KEY POINTS

- Active interventions when serum potassium is >6mmol/L
- Serum potassium >7mmol/L is a life threatening situation requiring urgent review and management.
- If uncertain – conference early to discuss management.

READ ACKNOWLEDGEMENT

- All NETS clinical staff are to read and acknowledge they understand the contents of this guideline.

CHANGE SUMMARY

Resonium polystyrene options provided.

Approved by:	SCHN Policy Procedure and Guideline Committee	NETS Executive
Date Effective:	1st August 2018	**Review Period:** 3 years
Team Leader:	Staff Specialist	**Area/Dept:** NETS

Rationale/Background

- To provide a framework for appropriate clinical therapy in the management of acute severe hyperkalaemia including identifying potential underlying causes and complications from the illness or treatment.
- ELBW babies born < 26 weeks are at risk of developing hyperkalaemia and should have a potassium checked at around 8 hours of life.

What is Hyperkalaemia?

Hyperkalaemia is defined as serum potassium level > 5.5 mmol/L in children and > 6 mmol/L in neonates. Elevated potassium is associated with cardiac conduction anomalies and arrhythmias and is therefore a potentially life threatening emergency. *Treatment must be prompt.*

Causes of hyperkalaemia

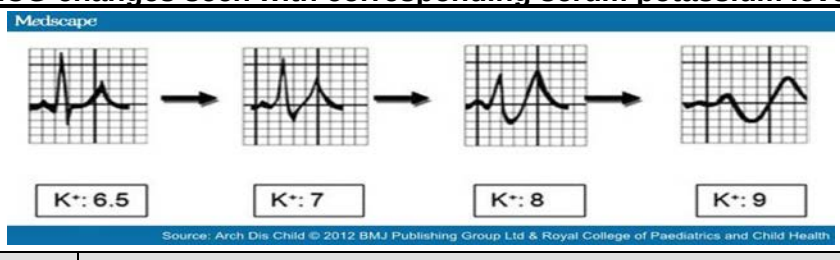
Hyperkalaemia might be an artefact of the collection process owing to haemolysis or poor technique. **However, never assume pseudo-hyperkalaemia; repeat blood samples immediately with a free flowing venous or arterial sample.** In an otherwise well infant do not base treatment on a capillary blood sample alone. Causes include:

- Renal failure the most common cause.
- Excessive load (blood transfusion, trauma, burns, errors in IV potassium administration)
- Transcellular potassium shift (acidosis)
- Reduced excretion (ARF, CRF, adrenal insufficiency, hypovolaemia)

Clinical features of acute hyperkalaemia

Hyperkalaemia can be asymptomatic or present with respiratory depression, paraesthesia, palpitations, arrhythmia or cardiac arrest. **All patients with elevated potassium levels must have ECG monitoring in place. Treat any ECG changes as a medical emergency – see Figure one.** Effect of hyperkalaemia on myocardium might vary with the rate of rise, any underlying conditions and is enhanced with hypocalcaemia, hyponatraemia and metabolic acidosis. Remember, arrhythmia can occur at any time and ventricular fibrillation may be the first cardiac manifestation.

Figure one – ECG changes seen with corresponding serum potassium level



Serum potassium (mmol/L)	ECG Manifestations
5.5-6.5	Tall, peaked, “tent-like” T waves, normal or decreased QT interval, PR interval shortening
6.5-7.5	Widening of QRS complex, increased PR interval

7 - 8	Broad, low-amplitude P waves, T prolongation, ST elevation

Management

- Follow ABC approach. Administer oxygen as hypoxia potentiates the risk of arrhythmias.
- Ensure the patient is not receiving any supplemental potassium, including potassium sparing diuretics and formula feeds in infants.
- Recheck plasma potassium levels urgently together with samples for urea, creatinine, electrolytes, glucose and VBG and ensure the patient is not receiving any supplemental potassium, including potassium sparing diuretics and monitor potassium levels frequently.
- Treatment of severe hyperkalaemia is independent of the cause – treated with fast acting potassium shifting therapies (salbutamol, glucose +/- insulin, sodium bicarbonate) and slower acting potassium removing therapies (frusemide, Resonium A, dialysis).

Intravenous Calcium(2.2mmol/L in 10mL)

- **Calcium gluconate 10%** 0.7 mL/kg to a maximum of 30 mL (6.6mmol calcium) administered as a slow IV infusion over 2-5 min.1.9g)

  Calcium chloride can be given if calcium gluconate is unavailable but is more likely to cause extravasation injury.
- **Calcium chloride 10%** 0.2 mL/kg to a maximum of 10 mL (6.8 mmol calcium) administered as a slow IV infusion over 2-5 min.
- **Caution:** Do not give calcium with bicarbonate as it will cause precipitation. Do not give if digoxin toxicity or tumor-lysis syndrome are suspected.

Calcium provides cardiac protection by causing a decrease in membrane resting potential. Onset of action is 1-3 min and lasts for 30 min. A second dose should be given after 5 min if ECG changes persist.

Glucose 10% + insulin

- **Dose:** 5 mL/kg IV of 10% glucose + Actrapid insulin 0.1 unit/kg as a slow push over 5 minutes (to a maximum of 10 units)
- **Caution:** Monitor for hypoglycaemia.

Glucose infusion enhances endogenous insulin production in non-diabetics. Insulin lowers potassium by intracellular exchange for sodium. Higher levels of insulin are required to be therapeutic. Onset of action is 15 min and lasts for 2 hours. Dosing can be repeated after 30 min.

Beta-adrenergic agonists

- **Nebulised salbutamol**
  - < 25 kg (including neonates) – 2.5 mg
  - > 25 kg – 5 mg

- **Intravenous salbutamol** (patients of all ages, including neonates) 4 micrograms/kg (maximum of 250 microgram/dose) administered over 15 min
- **Caution:** Tachycardia is the main side effect. *Be aware that there might be a transient rise in serum potassium in the first minute of administration of salbutamol which is why it shouldn't be used as sole first line treatment of severe hyperkalaemia*.

Beta 2-agonists drive potassium intracellular by increasing sodium potassium ATPase activity and it also increases endogenous insulin secretion. Doses can be repeated; onset is within 20 minutes and lasts for few hours. Consider giving nebulised salbutamol early whilst preparing IV infusions.

Sodium bicarbonate

- **Dose:**
  - 1mL/kg of 8.4% (1 mmol/ml) sodium bicarbonate solution IV, give as slow push over 5-10 min.
  - In the **neonate** give more slowly and dilute 1:1 with water for injection.
- **Caution:** Do not use as sole agent in treatment of hyperkalaemia. Do not give simultaneously with calcium to avoid precipitation. It may cause hypocalcaemia, hypernatraemia and volume overload, particularly in patients with renal dysfunction.

Sodium bicarbonate is more effective in the presence of metabolic acidosis. With correction of a metabolic acidosis, potassium is driven back into cells. However, there is only limited evidence that sodium bicarbonate is beneficial in acute hyperkalaemia. It is likely to be effective in enhancing urinary potassium elimination in patients with normal renal kidney function.

Ion exchange resin

- **Dose:** sodium polystyrene sulfonate (Resonium) 1g/kg orally or rectally (maximum dose 30g)
- **Caution:** Contraindicated with reduced gastric motility, perforation or recent abdominal surgery. There is a small associated risk of intestinal necrosis
- **Note:** Resonium is not recommended in neonates

Cation exchange resins act by binding potassium in the colon in exchange for sodium (Resonium A) or calcium (Calcium Resonium). Onset is relatively slow (1-2 hours) and it may be used as a long term agent. There is limited data on effectiveness of resins especially in the emergency setting. Most hospitals stock and use Resonium A. Calcium resonium is usually preferred when patients are hypertensive to avoid large amounts of sodium being absorbed.

Further principles for treatment of hyperkalaemia:

1. Early involvement of senior medical staff.
2. PICU involvement / admission.
3. Consider involving renal or endocrine teams.
4. Establishing urine output with fluid replacement and resuscitation.

5. Salbutamol and glucose + insulin have additive effect but are short term treatments while definitive treatment is being initiated.
6. Haemodialysis is the definitive method of potassium removal in the absence of normal renal function.

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Hyperkalaemia Algorithm

Potassium >6.0mmol/L

Stop Potassium containing fluids / drugs. Consider and address precipitating factors

A, B, C, oxygen, cardiac monitoring and repeat sample

Discuss with consultant and involve ICU early

Stabilise Cardiac Membrane

IV Calcium Gluconate 10% 0.5mL/kg (max. 4.4 mmol or 2g = 20 mL)

Or

IV Calcium Chloride 10% 0.2 mL/kg (max. 4.4 mmol or 2g = 10mL)

Shift Potassium into cells

- **IV Glucose 10% 5mL/kg + 0.1 units/kg Actrapid** (mixed in same syringe), give over 5min
- **Nebulised salbutamol** < 5 years 2.5 mg >5years 5 mg

Or

- **IV salbutamol** 4micrograms/kg over 15 min

Consider **Sodium Bicarbonate 8.4%** 1 mL/kg

Remove Potassium from body

- **Resonium A** 1g/kg orally or rectally
- Consider Haemodialysis

References

1. Weisberg L, Management of severe hyperkalaemia, Crit. Care Med, 2008, Vol 36, No 12
2. Mahoney B et al, Emergency interventions for hyperkalaemia, Review, Cochrane Collaboration, 2009
3. Masilamani K, The management of acute hyperkalaemia in neonates and children, Arch Dis Child., 2012 376-380
4. Clinical Practical Guidelines, The Royal Children's Hospital, Melbourne, 2016
5. Emergency Department Management of Hyperkalaemia, Sydney Children's Hospital 2011
6. Ahee P et al, The management of hyperkalaemia in the emergency department, J Accid Emerg Med 2000, 17, 188-191.
7. McKie, A, Emergency management of hyperkalaemia, www.clinicalguidelines.scot.nhs.uk
8. Mandelberg A, Salbutamol metered -dose inhaler with spacer for hyperkalaemia: how fast? How safe? Chest, 1999
9. British National Formulary for Children – Salbutamol monograph, sodium bicarbonate monograph (accessed 18/06/2018)
10. Australian Medicines Handbook – Children's Dosing Companion – Calcium monograph, salbutamol monograph, (accessed 18/06/2018)
11. Micromedex – calcium chloride monograph, calcium gluconate monograph, sodium bicarbonate monograph (accessed 18/06/2018)