In-patient Emergency Management of hyperkalaemia in children and neonates

Inclusion Criteria	Exclusion Criteria
• **Paediatric** patient (> 1 month age) with a serum potassium level of **≥ 5.5 mmol/L** • **Term Neonatal** patient (≤ 1 month age) with serum potassium level of **> 6 mmol/L**	• Post-operative cardiac patients in the intensive care unit • Premature Neonates • Patients in the neonatal intensive care unit and special care nursery

Caution:

- Exclude fictitious causes or lysed blood sample
- Check renal function if not done so (send urgent renal panel)
- Repeat with iSTAT if critical
- Review medications/infusions (look for exogenous K^+ sources, drugs which decrease renal K^+ excretion or cause transcellular K^+ shift)

Emergency Management of Hyperkalaemia algorithm

Age > 1 month old AND K^+ ≥ 5.5 mmol/L
Age ≤ 1 month, full term AND K^+ ≥ 6 mmol/L
Perform ECG immediately
Review all medications/infusions

Potassium level	**K^+ 5.5 - 6 mmol/L**	**K^+ 6.1 – 6.9 mmol/L**	**ECG abnormal OR K^+ > 7 mmol/L**
Initial treatment	If acute and ongoing cause: 1. Salbutamol neb 2. PR/PO resonium If CRF patient: 1. PR/PO resonium 2. Diet modification 3. Inform nephrologist	• Cardiac monitoring • **To High Dependency** • Inform senior staff Administer: 1. Salbutamol neb 2. IV dextrose/Insulin 3. PR/PO resonium (omit if served in the last 2hrs) *4. +/- sodium bicarbonate (if pH < 7.2)*	• Cardiac monitoring • **To CICU** • Inform senior staff Administer: 1. Calcium gluconate OR Calcium chloride 2. Salbutamol neb 3. IV dextrose/Insulin 5. PR/PO resonium (omit if served in the last 2hrs) *4. +/- sodium bicarbonate (if pH < 7.2)*
Review	**Review K^+ in 1 hr**	**Review K^+ and H/C in 1 hour**	**Review K^+, H/C and ECG in 30 min**
Further management	**K^+ improving:** • Continue monitoring until normalised • If **K^+: 5.5 - 6**, can repeat salbutamol Neb until normal **K^+ NOT improving:** • re-evaluate for cause • If **K^+ > 6**, escalate to next level of management	**K^+ improving:** • Continue monitoring until normalised • If **K^+: 5.5 - 6.9**, can repeat salbutamol +/- dextrose/insulin until normal **K^+ NOT improving:** • re-evaluate for cause • If **K^+ > 6.9**, escalate to next level of management	**K^+ improving:** • Continue monitoring until normalised • can repeat salbutamol +/- dextrose/insulin **K^+ NOT improving:** • re-evaluate for cause • If ECG changes persist, can repeat Calcium • Consider CRRT

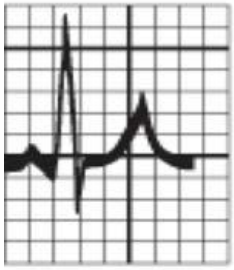
Emergency Management of Hyperkalaemia PAEDIATRIC DRUGS

Drug Name	Dosage and route	Onset of action	Duration	Comments
Salbutamol 0.5% solution	Nebulised with 8L/gas flow: < 25kg: 2.5mg in 4 ml N/S Q1-2H >25kg: 5mg in 4 ml N/S Q1-2H	30 – 60 min	3 to 4 hours	May cause tachycardia. May be repeated
Insulin	IV 0.1 unit/kg/DOSE (Max 10 units/DOSE) To take 50 units using insulin syringe and reconstitute to 50 mL in normal saline => Final concentration is **1 unit per mL** ****Administer appropriate dose using diluted solution****	15 – 20 min	4 to 6 hours	1 unit to every 5 g of glucose May cause hypoglycaemia ****Monitor hypocount 1 hr after dose**** May be repeated
Dextrose 10%	IV 5 mL/kg/DOSE	-	-	To administer with IV insulin
Dextrose 50%	IV 1 mL/kg/DOSE ****requires central venous or large bore peripheral venous access****	-	-	To administer with IV insulin
Sodium resonium (Sodium Polystyrene Sulfonate)	PO 1 g/kg/DOSE (Max 15 to 30 g/DOSE) Q8H PR 1 g/kg/DOSE (Max 30 to 60 g/DOSE) Q2-6H (evacuate previous dose before administration)	1 to 2 hours	4 to 6 hours	Contraindicated if ileus, recent abdominal surgery, or perforated gut. Contraindicated in neonates with reduced gut motility. May cause nausea, constipation, paralytic ileus or diarrhoea May be repeated
10% Calcium gluconate (2.25mmol/10mL)	IV 0.5 to 1 mL/kg/DOSE over 10 minutes (Max IV 30 mL/DOSE)	5 to 10 min	30 to 60 min	May cause hypercalcaemia or tissue necrosis May be repeated if ECG changes persist
10% Calcium chloride (5.5mmol/10mL)	IV 0.2 mL /kg/DOSE (max 20mL) over 10 minutes ****May use in place of calcium gluconate if fluid restricted****	-	-	May cause hypercalcaemia or tissue necrosis May be repeated if ECG changes persist
Sodium bicarbonate 8.4% (1mmol/mL)	IV 1 mL/kg/DOSE over 10 to 15 min (Max IV 50 mMol/DOSE) To dilute with equal parts W.F.I. to make up 4.2% solution before administration	4 to 6 hours	4 to 6 hours	May cause sodium overload / hypertension. May use when evidence of acidaemia present (pH <7.2; serum HCO_3 <15 mEq/L) ****Not to give simultaneously with calcium****

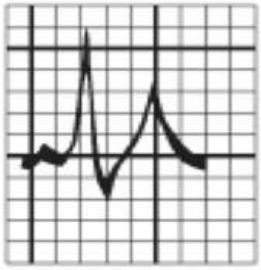
Comments

1. Salbutamol is a preferred first-line treatment for hyperkalaemia because of ease of administration while other treatments are being prepared.
2. Concentrated insulin is a high-alert medication, and care should be taken in its dilution and preparation.
3. Salbutamol and insulin are short term treatments for hyperkalaemia, and can be repeated. Efforts should be made in the meantime to identify and treat the underlying cause.

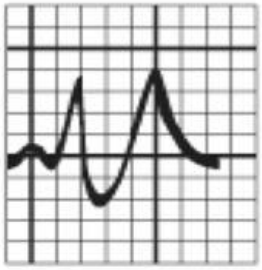
ECG changes in hyperkalaemia



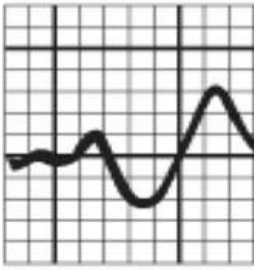
Tall tented T-waves



Widened QRS interval



Flattened P waves



Sine wave pattern (S and T waves merging)

Narrow peaked T waves, U waves, shortened QT intervals, prolonged PR intervals, prolonged QRS intervals, loss of P wave, sine waves and ultimately ventricular fibrillation may be present in patients with hyperkalaemia. ECG changes do not necessarily progress in the above order in relation to the degree of hyperkalaemia, and there is poor correlation between ECG changes and serum potassium concentration.

Hyperkalaemia with ECG changes is a MEDICAL EMERGENCY and requires IMMEDIATE attention.

Reference:

1. Masilamani K, van der Voort J. The management of acute hyperkalaemia in neonates and children. *Arch Dis Child* 2012;97:376-380
2. Lehnhardt A, Kemper MJ. Pathogenesis, diagnosis and management of hyperkalemia. *Pediatr Nephrol* 2011;26: 377-384
3. O'Hare FM, Molloy EJ. What is the best treatment for hyperkalaemia in a preterm infant? *Arch Dis Child* 2008;93:174-176
4. Khanna A, White WB. The management of hyperkalemia in patients with cardiovascular disease. *Am J Med.* 2009 Mar;122(3):215-21
5. Shingarev R, Allon M. A physiologic-based approach to the treatment of acute hyperkalemia. *Am J Kidney Dis*. 2010 Sep;56(3):578-84
6. Lexi-Comp online, accessed 27th May 2013
7. Clinical Practice Guidelines : Hyperkalemia. Royal Children's Hospital, Melbourne Australia August 2011
8. Starship Children's Health Clinical Guideline: Hyperkalemia. April 2011
9. Emergency Management of Hyperkalemia. Pediatric Intensive Care Unit. Royal Hospital for Sick Children. NHS Greater Glasgow and Clyde. Oct 2010
10. Emergency interventions for hyperkalaemia (Review). The Cochrane Library 2009 Issue 3.
11. Hollander-Rodriguez JC, Calvert JF Jr. Hyperkalemia. Am Fam Physician. 2006 Jan 15;73(2):283-90
12. Mildenberger E, Versmold HT. Pathogenesis and therapy of non-oliguric hyperkalaemia of the premature infant. Eur J Pediatr. 2002 Aug;161(8):415-22.
13. Phelps SJ, Emily BH, Crill CM. 2010. "Calcium Chloride", in Pediatric Injectable Drugs – the Teddy Bear Book. (9th Edition). Maryland: American Society of Health-System Pharmacists, Inc.