Clinical Guidelines

Hyperkalaemia

Document Control Information

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<th>Applicable to</th>
<th>All CATS employees</th>
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Cardiac arrest with hyperkalaemia

- This may be VF, pulseless VT, asystole or PEA
- In all scenarios it is difficult to re-establish sinus rhythm without lowering the serum potassium
- Give the following:
  - 10% calcium gluconate 0.5ml/kg IV (max. 30ml) over 2-5 minutes
  - Sodium bicarbonate 1-2mmol/kg IV (max 50mmol) 1mmol = 1ml of 8.4% solution
  - Consider giving adrenaline earlier if on shockable side of the algorithm

Consider insulin/glucose bolus as follows: IV bolus of 0.1units/kg (max 10units) human soluble insulin (Actrapid®) WITH 10mL/kg 10% glucose

What is Hyperkalaemia & when should I treat?

Hyperkalaemia is defined as potassium (K+) >5.5mmol/L

- Mild: K+ 5.5 – 6.0
- Moderate: K+ 6.1 - 6.9
- Severe: K+ > 7.0

ECG changes are typically progressive and are not usually seen below potassium levels of 7mmol/L

How rapidly potassium rises may be more important than how high the actual level is:

- Patients without ECG changes can suddenly go into cardiac arrest
- A child with chronic renal failure may tolerate high levels of potassium without any ECG change

Treat if:

- K+ levels are > 6.0mmol/L
- ECG changes are present
Each case should be considered carefully, and treatment instigated promptly, without waiting for laboratory confirmation or repeat blood test results, in acutely unwell children especially patients with:

- Suspected renal impairment
- Oliguria
- Significant acidosis
- ECG changes

Beware assuming collection technique ("squeezed sample") is to blame - if in doubt, treat.

**Causes of Hyperkalaemia**

**Increased load**
- Iatrogenic - infusion, transfusion of old blood

**Shift of potassium into the extracellular space**
- Excessive cell breakdown: haemolysis, tumour lysis, rhabdomyolysis, burns, trauma
- GI bleed
- Acidosis
- Familial hyperkalaemic periodic paralysis
- Hyperosmolar states: uncontrolled diabetes, glucose infusions

**Decreased excretion**
- Renal failure – acute or chronic
- Congenital adrenal hyperplasia
- Addison’s disease
- Primary hypoaldosteronism/pseudohypoaldosteronism
- Type IV RTA
- Potassium sparing diuretics

**Examples of drugs which may cause hyperkalaemia:**
- ACE inhibitors, digoxin, suxamethonium, spironolactone

**Pseudohyperkalaemia**
- Sampling error - drawn from the same line as potassium infusion
- Laboratory error
- Leucocytosis and/or thrombocytosis
Management

ABC assessment as per APLS:

Airway

- If indication for intubation, avoid use of suxamethonium, which can exacerbate hyperkalaemia.

Breathing

- If mechanically ventilated, consider aiming for mild respiratory alkalosis by increasing the rate

Circulation

- Start continuous ECG monitoring immediately and check the blood pressure
- Place appropriately sized defibrillator pads on the patient.
- 12 lead ECG
- Repeat U&E & blood gas to be sent emergently
- Treat arrhythmias as per APLS protocols - the child may present with:
  - Peaked T waves or loss of P wave
  - Widened QRS
  - Bradycardia
  - Junctional rhythm
  - VT, VF

Specific treatment (for age specific doses/full dosing information for all therapy see Appendix A)

1. Stop all exogenous potassium

- Potassium containing intravenous (IV) fluids and parenteral nutrition
- Enteral potassium supplements
- Drugs affecting potassium accumulation (see Appendix)
- Stop red blood cell transfusions
2. Membrane stabilisation - to antagonize the effects of potassium but will NOT lower potassium

10% Calcium Gluconate
- If ECG changes present, give 0.5ml/kg IV (max. 30ml) of 10% calcium gluconate over 5-10 minutes. Administration: Central iv access: can give neat. Peripheral: dilute to a maximum concentration of 0.045mmol calcium in 1ml
- If ECG changes are still present after 5 minutes, a repeat dose can be given.

3. Decrease serum potassium levels - by promoting the movement of potassium intracellularly

Salbutamol
- Can be given as salbutamol nebulisation (2.5-5mg, repeated if necessary) or intravenously 4micrograms/kg (max 250micrograms)
- Do not use as sole therapy in moderate/severe hyperkalaemia as 25-40% of people do not show hypokalaemic effect with salbutamol.

Insulin/glucose therapy
- Start human soluble insulin (Actrapid®) infusion: neonates: 0.3 – 0.6 units/kg/hr, > 1 month 0.05 - 0.2 units/kg/hour with glucose 0.5-1g/kg/hr (i.e. 5-10ml/kg/hr of glucose 10%)
- Insulin should always be given with a glucose infusion to avoid hypoglycaemia.
- Insulin & glucose should run through the same cannula to ensure both infusions stop if the IV-line blocks or leaks. Ensure the octopus being used has non return valves on each lumen.
- Glucose and K⁺ levels should both be monitored.
- Aim for glucose > 6mmol/L and monitor levels every 15 minutes for the first hour.

Sodium Bicarbonate IV
- If severe acidosis is present, give 1mmol/kg (max 50mmol) sodium bicarbonate iv (1mmol = 1ml of 8.4% solution) - may be repeated if needed

4. Removing potassium from the body

Furosemide
- 1 – 5mg/kg iv (max 50mg) may be effective depending upon renal status

Calcium polystyrene sulfonate (calcium resonium)
- Calcium polystyrene sulfonate is not used for acute treatment of hyperkalaemia
Renal replacement therapy (CRRT, PD or HD)

- Discuss with CATS consultant

Transport considerations

- During transport, monitor patient’s ECG through pads on defibrillator. Remember to place pads on before securing in baby pod or ACR.
- Insulin & glucose should run through the same cannula to ensure both infusions stop if the IV-line blocks or leaks. Ensure the octopus being used has non-return valves on each lumen.
- Glucose level may need to be monitored depending on transit time.
- Prepare boluses of calcium gluconate, adrenaline (arrest dose), sodium bicarbonate and glucose, as well as sodium chloride 0.9% for flushes.
- Have intraosseous equipment easily accessible.
### Appendix A – Age and gestation specific dosing

| Calcium gluconate 10% IV (first line calcium salt for hyperkalaemia) |  |
|---|---|---|
| **Dose** | **Concentration** | **Rate** |
| 0.5ml/kg (=0.11mmol/kg) Max. dose 30ml (6.75mmol) | Ideally give CENTRALLY as can cause tissue necrosis on extravasation. | Can give over 5-10minutes Note rapid infusions can cause tissue necrosis on extravasation |
| 1ml of 10% Calcium Gluconate contains 0.225mmol of calcium | If only peripheral access is available, dilute to a max concentration of 0.045mmol per ml |  |
| In arrest: 0.5ml/kg of 10% calcium gluconate (max 30ml) | NEAT via Central line/IO (or peripheral if no other access possible) | Over 2-5 minutes |

Incompatible with bicarbonate, phosphate & ceftriaxone, use large vein - local irritant.

### Insulin/Glucose infusion

| Human soluble insulin (Actrapid®) IV infusion |  |
|---|---|---|
| **Dose** | **Concentration** | **Rate** |
| **Neonates:** 0.1-0.6units/kg/hour | 50 units Actrapid® in 50ml sodium chloride 0.9% | 0.1 – 0.6ml/ kg / hr |
| **Children >1 month:** 0.05 – 0.2 units/kg/hr | 50 units Actrapid® in 50ml sodium chloride 0.9% | 0.05 – 0.2ml/ kg/hr |

### Glucose IV infusion

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<th><strong>Dose</strong></th>
<th><strong>Concentration</strong></th>
<th><strong>Rate</strong></th>
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<tbody>
<tr>
<td>0.5-1g/kg/hr</td>
<td>10% Glucose (100mg/ml)</td>
<td>5 - 10ml/ kg / hr</td>
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<td></td>
<td>20% Glucose (200mg/ml) <strong>central only</strong></td>
<td>2.5 – 5ml/ kg /hr</td>
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<tr>
<td></td>
<td>50% Glucose (500mg/ml) <strong>central only</strong></td>
<td>1 - 2ml/ kg /hr</td>
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Infuse insulin & glucose via same cannula with connector with two non-return valves rather than a three-way tap.

### Salbutamol

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<tr>
<th>Salbutamol nebuliser</th>
<th><strong>Dose</strong></th>
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<tr>
<td>All Ages</td>
<td>2.5mg – 5mg neb (repeated if necessary)</td>
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<tr>
<th>Salbutamol intravenous</th>
<th><strong>Dose</strong></th>
<th><strong>Concentration</strong></th>
<th><strong>Rate</strong></th>
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<td>Neonate &amp; child 4microgram/kg</td>
<td>Dilute to 50microgram/ml</td>
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<td>Over 5 minutes</td>
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**Sodium Bicarbonate IV**

1ml of 8.4% sodium bicarbonate = 1mmol sodium & 1mmol bicarbonate
1ml of 4.2% sodium bicarbonate = 0.5mmol sodium & 0.5mmol bicarbonate

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<th>Dose (&gt;1mth)</th>
<th>Concentration</th>
<th>Rate</th>
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<tr>
<td><strong>Severe metabolic acidosis</strong>&lt;br&gt;<strong>Full correction:</strong>&lt;br&gt;Total number of mmol bicarb = wt (kg) x base deficit (mmol/L) x F</td>
<td><strong>Diluent:</strong> 5% glucose, 10% glucose 0.9% sodium chloride</td>
<td>slow iv bolus over 20 - 30minutes</td>
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<td>Can be given neat via a central line in an emergency</td>
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<td></td>
<td>Give centrally wherever possible due to risk of extravasation &amp; high osmolarity.&lt;br&gt;&lt;br&gt;<strong>In an emergency, if only peripheral access is available:</strong>&lt;br&gt;</td>
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<td>&lt; 2years: Max conc. 0.5mmol/ml (4.2%)&lt;br&gt;(For each 1ml of 8.4% Sodium bicarbonate, add 1ml of diluent.)</td>
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<td>&gt;2 years: Max conc 1mmol/ml (8.4%) with extreme caution</td>
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<td><strong>In non-emergency situations:</strong>&lt;br&gt;&lt;br&gt;<strong>Central line:</strong>&lt;br&gt;Max. conc. 0.2mmol/ml (1.68%)&lt;br&gt;(For each 1ml of 8.4% sodium bicarbonate, add 4ml of diluent)</td>
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<td><strong>Peripheral:</strong> Max. conc. 0.1mmol/ml (0.84%)&lt;br&gt;(For each 1ml of 8.4% sodium bicarbonate add 9ml of diluent)</td>
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<td><strong>Hyperkalaemic cardiac arrest/severe renal hyperkalaemia:</strong> TCA overdose:&lt;br&gt;1 - 2mmol/kg (max 50mmol)</td>
<td>Can give neat in an emergency&lt;br&gt;Give centrally wherever possible</td>
<td>Slow iv bolus over 20-30mins</td>
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Incompatible – calcium (precipitates), dopamine & adrenaline (inactivates). Additions should never be made to sodium bicarbonate, and it should not be infused via the same line as any other infusion, particularly calcium and magnesium salts.
References