Guideline

Hyperkalaemia – Emergency Management in Children

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Executive sponsor	Executive Director Medical Services			**Effective date**	22/09/2020
Author/custodian	Senior Medical Officer, Emergency Department			**Review date**	22/09/2023
Supersedes	New				
Applicable to	All staff involved in the care and emergency management of children with hyperkalaemia				
Authorisation	Executive Director Clinical Services (QCH)				

Purpose

This purpose of this guideline is to provide clinical advice for guidance in the management and care of a paediatric patient with acute hyperkalaemia in Queensland.

Hyperkalaemia presentations requires management in a step-wise approach and this guideline places an emphasis on the recognition of patients with potentially life-threatening cardiac toxicity.

Scope

This guideline is intended to assist all clinical staff to care and manage hyperkalaemia appropriately for paediatric patients in Queensland. It is not intended to be a substitute for specific professional or clinical advice, or to replace consultation with senior staff, which should always be sought if clinically relevant.

This material is published by Queensland Health with the intention of providing a guideline for use at Queensland Children's Hospital. Anyone wishing to use this guideline outside QCH should refer to their local Medicines Committee before using.

Guideline

Definition

Hyperkalaemia is defined as a serum potassium of greater than 5.5 mmol/L in a child or greater than 6.0 mmol/L in a neonate.

ALERT

Severe hyperkalaemia (potassium greater than 7 mmol/L or greater than 6.5 mmol/L with ECG changes) is a medical emergency.

It is important to remember that patients with mild hyperkalaemia (potassium 5.5 – 6.0 mmol/L) and moderate hyperkalaemia (potassium 6.1 – 7.0 mmol/L) may also have ECG changes which are potentially life-threatening.

Causes

Mechanism	Cause
Pseudohyperkalaemia (Factitious hyperkalaemia)	Collection technique (haemolysis) Significant thrombocytosis (platelets > 1,000 x 10^9/L) Significant leucocytosis (WCC >70 x 10^9/L)

Impaired potassium excretion	Acute renal failure
	Chronic kidney disease
	Hypoaldosteronism
	  Primary adrenal insufficiency
	Tubular unresponsiveness to aldosterone
	  Obstructive nephropathy
	  Sickle cell disease
	Medications affecting Na+/K+ exchange
	  Potassium sparing diuretics
	  Angiotensin converting enzyme inhibitors
	  Angiotensin II receptor blockers
	  Trimethoprim
	  NSAIDs
	  Calcineurin inhibitors (tacrolimus and cyclosporin)

Redistribution of potassium from the intracellular to extracellular space	Acidosis
	Familial hyperkalaemic periodic paralysis
	Hypertonicity
	  Hyperglycaemia
	  Mannitol
	Medications
	  Succinylcholine
	  Beta blockers
	  Digoxin

Addition of potassium into	Potassium supplements or potassium containing IV fluids

extracellular space	Rhabdomyolysis Crush injury Tumour lysis syndrome Haemolysis

Assessment

Hyperkalaemia is usually asymptomatic. Where clinical signs and symptoms do exist, cardiac and neurological features tend to predominate.

ALERT

Hyperkalaemia may be life-threatening. Management of the elevated potassium should always take priority over any diagnostic evaluation.

History

Symptoms of hyperkalaemia:

- Nausea and vomiting
- Fatigue
- Paraesthesia, muscle weakness, paralysis
- Respiratory distress and failure
- Palpitations, syncope, cardiac arrest

Aetiology:

- Past medical history
- Full medication history (including any recent intravenous fluids and infusions)

Examination

The examination should be focused to identify the underlying aetiology and identify the complications of severe hyperkalaemia.

Examination findings suggestive of severe hyperkalaemia include haemodynamic instability, arrhythmia, diminished deep tendon reflexes, muscle weakness/paralysis and hypoventilation.

Investigations

ECG

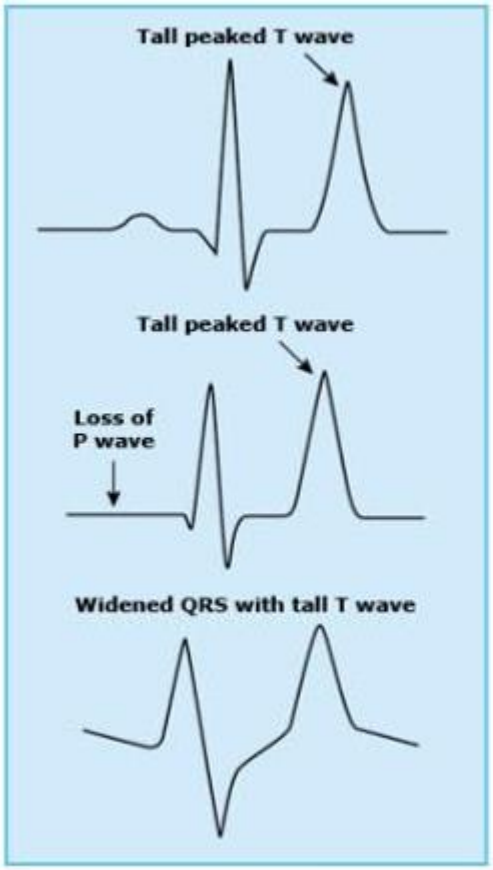
An ECG should be urgently performed to assess for conduction abnormality or arrhythmia.

ECG changes seem in hyperkalaemia include tall/peaked T waves (seen across all leads), prolonged PR interval, loss of P waves and widening of the QRS complex which is often described as 'broad and bizarre'. These changes can progress to sine waves, ventricular arrhythmias and asystole.

Whilst there is no definite correlation between specific serum potassium levels and ECG changes, the ECG changes of hyperkalaemia occur in a typical pattern. Patients with chronic hyperkalaemia may not have ECG changes despite high serum potassium levels.

Figure 1 – Typical electrocardiographic features of hyperkalaemia

From UpToDate

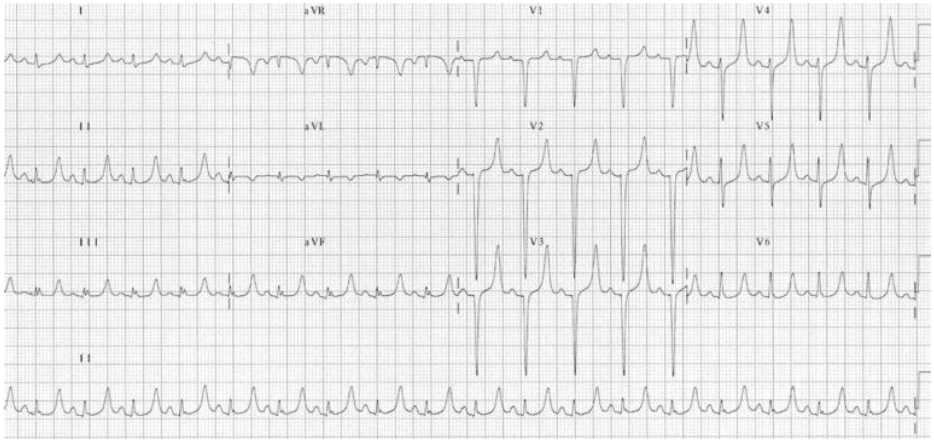


Serum potassium	Major change
5.5-6.5	Tall peaked T waves
6.5-7.5	Loss of P waves
7.0-8.0	Widening of QRS
8.0-10.0	Sine wave, ventricular arrhythmia, asystole

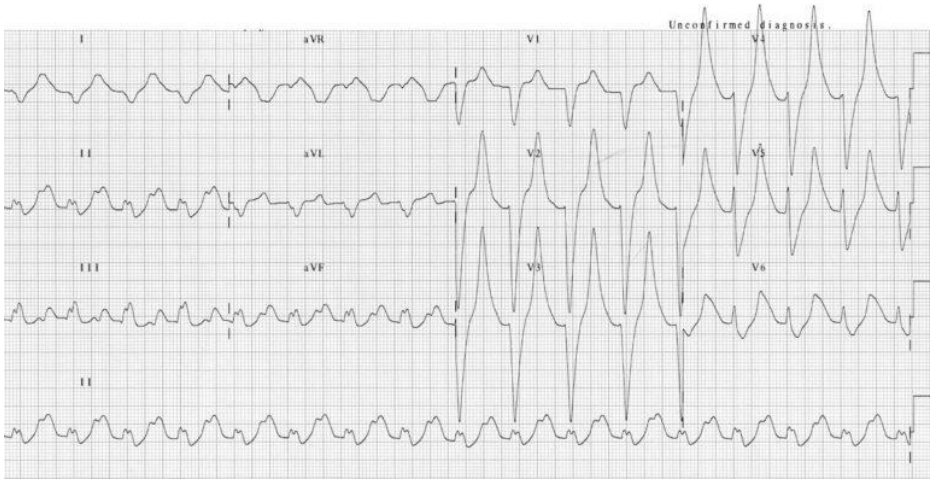
Adapted from: Mattu A, Brady WJ, Robinson DA. Electrocardiographic manifestations of hyperkalemia. Am J Emerg Med 2000; 18:721.

ECG examples

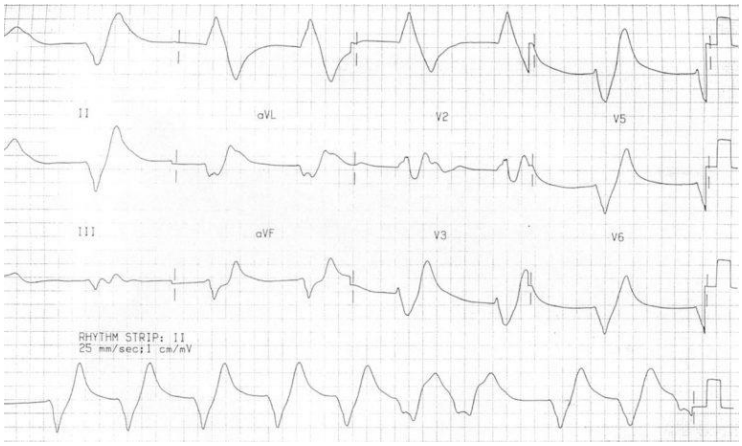
From Life in the Fastlane



Peaked T waves



Peaked T waves
Prolonged PR interval
Broad and bizarre QRS



Sine wave

Venous blood gas/iSTAT

Urgently perform a venous blood gas or iSTAT to confirm the potassium level. This should not delay the initiation of treatment, especially in severe hyperkalaemia.

ALERT

In patients with renal dysfunction you should assume the potassium level is correct until proven otherwise.

Renal function

Investigations to determine underlying aetiology should be guided by history and examination findings.

Management

ALERT

In acidosis potassium shifts from the intracellular space to the extracellular space. This means that patients with hyperkalaemia and acidosis may actually have a total body potassium deficit. Treat as per the guidelines below but ensure close monitoring of potassium levels as the acidosis corrects.

Severe hyperkalaemia: potassium greater than 7 mmol/L or greater than 6.5 mmol/L with ECG changes

ALERT

Severe hyperkalaemia may be life-threatening.

Step 1 – Prioritise patient care

- Notify senior medical staff
- Manage in a resuscitation area
- Instigate full cardiac monitoring
- Cease any potassium containing feeds/fluids
- Cease any medications that increase serum potassium or reduce potassium excretion
- Obtain central IV access where readily available (e.g. in patients with a port) or where achievable *without significant delay to treatment*. If central access not possible, obtain peripheral large vein IV access.
- Consider early discussion with renal and/or PICU
- If Tumour Lysis Syndrome suspected, refer to CHQ-GDL-XXXXX Tumour Lysis Syndrome Guideline (not yet finalised)

Step 2 - Protect the myocardium

10% Calcium gluconate	0.11 mmol/kg or 50 mg/kg Maximum: 4.4 mmol or 2000 mg Can be given neat (via CVL) or diluted (CVL or Peripheral) as per Intravenous Calcium Guideline Infuse over 3 to 5 minutes **Do not give with sodium bicarbonate**	Stabilises myocardium Reduces risk of arrhythmias Does not lower potassium **Contraindicated in patients with Tumour lysis syndrome, digoxin toxicity or hypercalcaemia** Risk of injury (Irritation/tissue necrosis) is high if infiltration/extravasation occurs

	Dose can be repeated after 15mins if ECG still abnormal	Onset of action: 5 minutes Duration of effect: 30 – 60 minutes

Calcium Gluconate monohydrate 2.2 mmol in 10mL [2]

- Dilute to standard concentrations as per dose table above.
  - 4.4 mmol in 40 mL (0.11 mmol/mL) (DERS)
  - 4.4 mmol in 100 mL (0.044 mmol/mL) (DERS)

  Or
  - 2.2 mmol in 100mL (manually configure in DERS)
- Dilute with either Sodium Chloride 0.9% or Glucose 5%
- Can be administered neat (0.22 mmol/mL) via Central Venous Access Device

Step 3 - Lower the serum potassium level

Salbutamol	Less than 6 years – 2.5 mg nebulised Greater than 6 years – 5 mg nebulised *****Nebulisation is considered an aerosol generating procedure*****	Onset of action: 5 – 30 minutes Maximum effect: 90 minutes Duration of effect: 3 hours Lowers potassium by: 0.5 – 1 mmol/L
Insulin/Glucose	Glucose 10% infused at rate of 5 mL/kg/hr PLUS Insulin (Actrapid) 0.1 unit/kg/hr	Start glucose infusion first Monitor BGL every 15 minutes Continue infusion until potassium is within range Onset of action: 10 – 20 minutes Maximum effect: 30 – 60 minutes Duration of effect: 4 – 6 hours Lowers potassium by: 0.5 – 1.2 mmol/L
Sodium bicarbonate	1 mmol/kg intravenous (via large vein) Infuse over 3 to 5 minutes	Use in metabolic acidosis Monitor pH to avoid alkalosis Onset of action: within 1 hour Duration of effect: up to 2 hours Effect small and inconsistent
Furosemide	1 mg/kg intravenous Infuse over 20 minutes	Use as adjuvant therapy after consultation with renal or PICU Onset of action: within 1 – 2 hours

Step 4 - Promote the elimination of potassium from the body

Sodium polystyrene sulfonate (Resonium A®)	0.25 gram/kg orally or rectally Max 15g To prepare rectal preparation mix each 1 g with 5 mL of water or glucose	Contraindicated in recent abdominal surgery, perforation, ileus and hypernatraemia Onset of action: within 1 – 2 hours

	10% (retention of water-based dispersion is more difficult) Can be repeated up to four times/day	Duration of effect: 4 – 6 hours
Dialysis		Indicated in life-threatening hyperkalaemia or when pharmacological therapies fail Early liaison with renal and/or PICU

Moderate hyperkalaemia: potassium 6.1 – 7 mmol/L without ECG changes

Step 1 – Prioritise patient care

- Notify senior medical staff
- Manage in a resuscitation area
- Instigate full cardiac monitoring
- Cease any potassium containing feeds/fluids
- Cease any medications that increase serum potassium or reduce potassium excretion
- Obtain IV access
- Consider early discussion with renal and/or PICU

Step 2 - Lower the serum potassium level

Salbutamol	Less than 6 years – 2.5 mg nebulised Greater than 6 years – 5 mg nebulised *****Nebulisation is considered an aerosol generating procedure*****	Onset of action: 5 – 30 minutes Maximum effect: 90 minutes Duration of effect: 3 hours Lowers potassium by: 0.5 – 1 mmol/L
Insulin/Glucose	Glucose 10% infused at rate of 5 mL/kg/hr PLUS Insulin (Actrapid) 0.1 unit/kg/hr	Start glucose infusion first Monitor BGL every 15 minutes Continue infusion until potassium is within range Onset of action: 10 – 20 minutes Maximum effect: 30 – 60 minutes Duration of effect: 4 – 6 hours Lowers potassium by: 0.5 – 1.2 mmol/L
Sodium bicarbonate	1 mmol/kg intravenous (large vein) Infuse over 3 to 5 minutes	Use in metabolic acidosis Monitor pH to avoid alkalosis Onset of action: within 1 hour Duration of effect: up to 2 hours Effect small and inconsistent

Furosemide	1 mg/kg intravenous Infuse over 20 minutes	Use as adjuvant therapy after consultation with renal or PICU Onset of action: within 1 – 2 hours

Step 3 - Promote the elimination of potassium from the body

Sodium polystyrene sulfonate (Resonium A®)	0.25 gram/kg orally or rectally Max 15 g To prepare rectal preparation mix each 1 g with 5 mL of water or glucose 10% (retention of water-based dispersion is more difficult) Can be repeated up to four times/day	Contraindicated in recent abdominal surgery, perforation, ileus and hypernatraemia Onset of action: within 1 – 2 hours Duration of effect: 4 – 6 hours

Mild hyperkalaemia: potassium 5.5 – 6.0 mmol/L, no ECG changes and asymptomatic patient

Step 1 – Prioritise patient care

- Cease any potassium containing feeds/fluids
- Cease any medications that increase serum potassium or reduce potassium excretion

Step 2 - Consider whether treatment is necessary

If required:

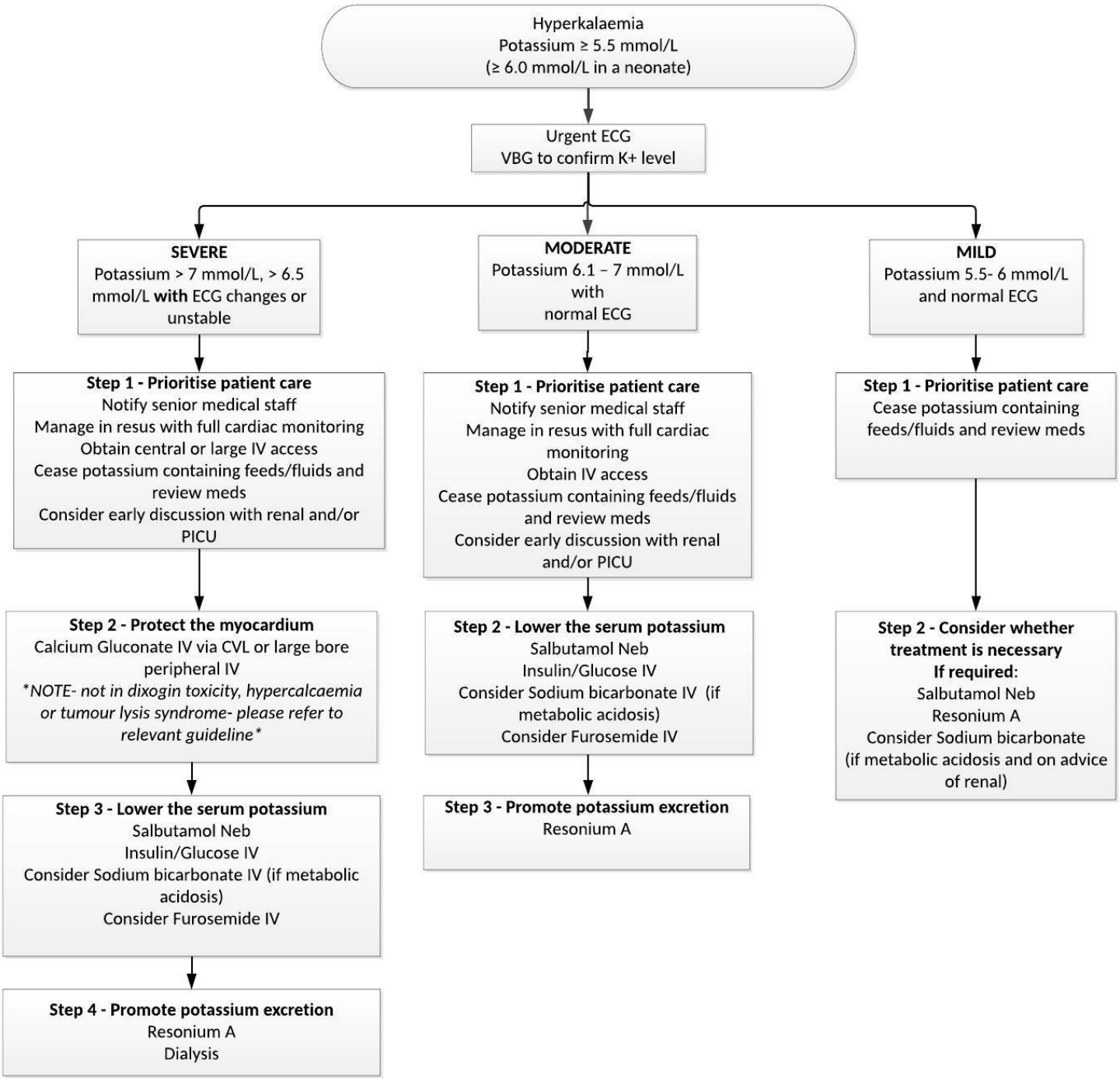
Salbutamol	Less than 6 years – 2.5 mg nebulised Greater than 6 years – 5 mg nebulised *****Nebulisation is considered an aerosol generating procedure*****	Onset of action: 5 – 30 minutes Maximum effect: 90 minutes Duration of effect: 3 hours Lowers potassium by: 0.5 – 1 mmol/L
Sodium polystyrene sulfonate (Resonium A®)	0.25 gram/kg orally or rectally Max 15 g To prepare rectal preparation mix each 1 g with 5 mL of water or glucose 10% (retention of water-based dispersion is more difficult) Can be repeated up to four times/day	Contraindicated in recent abdominal surgery, perforation, ileus and hypernatraemia Onset of action: within 1 – 2 hours Duration of effect: 4 – 6 hours
Sodium bicarbonate	1 mmol/kg intravenous (large vein) Infuse over 3 to 5 minutes	Use only in metabolic acidosis (after consultation with renal) Monitor pH to avoid alkalosis

		Onset of action: within 1 hour Duration of effect: up to 2 hours Effect small and inconsistent

ALERT

Patients with marked tissue breakdown (rhabdomyolysis, crush injury, tumour lysis syndrome (CHQ-GDL-XXXXX Tumour Lysis Syndrome Guideline (not yet finalised) may require aggressive therapy to remove potassium despite only mild hyperkalaemia.

Hyperkalaemia – Emergency management in children - Flowchart



Consultation

Key stakeholders who reviewed this version:

- Senior Medical Officer Renal
- Senior Medical Officer PICU
- Senior Medical Officers Emergency
- Pharmacist Lead Critical Care

Definition of terms

Term	Definition
Hyperkalaemia	Serum potassium greater than 5.5mmol/L (greater than 6.0mmol/L in a neonate). Further classified by severity: Mild: 5.5 – 6 mmol/L Moderate: 6.1 – 7 mmol/L Severe: greater than 7 mmol/L or greater than 6.5 mmol/L with ECG changes
Pseudohyperkalaemia	Falsely elevated serum potassium level greater than 5.5mmol/L

References and suggested reading

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Guideline revision and approval history

Version No.	Modified by	Amendments authorised by	Approved by
1.0 22/09/2020	Senior Medical Officer, Emergency Department	Divisional Director, Critical Care	Executive Director Clinical Services QCH

Keywords	Hyperkalaemia, calcium Gluconate, pseudohyperkalaemia, resonium, 00176
Accreditation references	NSQHS Standards (1-8): 1 Clinical Governance, 4 Medication Safety,8 Recognising and Responding to Acute Deterioration ISO 9001:2015 Quality Management Systems: (4-10)

Appendix 1:

Calcium

Drug & Presentation	Reconstitution & Dilution	Final drug concentration	Dosage range	Route & administration	Comments
Calcium Gluconate	4.4 mmol in 40mL with glucose 5% or sodium chloride 0.9%	0.11 mmol/mL	0.01 to 0.09 mmol/kg/hr	CENTRAL ACCESS, can be given peripherally over 10-60 mins	Cease if bradycardic

Insulin/Glucose

Drug & Presentation	Reconstitution & Dilution	Final drug concentration	Dosage range	Route & administration	Comments
Insulin (ACTRAPID)	50 units in 50 mL with 0.9% sodium chloride	1 unit/mL	0.05 to 0.3 units/kg/hr	PERIPHERAL ACCESS	Stored in fridge
PLUS (as a separate infusion) 10% Glucose at 5 mL/kg/hr					

Taken from the Paediatric Emergency Resuscitation Infusion Guideline which can be found at https://qheps.health.qld.gov.au/__data/assets/pdf_file/0036/2317698/gdl-00752.pdf