Scope

This guideline is aimed at all Health care professionals involved in the care of infants within the Neonatal Service.

Key Points

- Hyperkalaemia is defined as serum potassium level of >6.5 mmol/L
- Hyperkalaemia is common in small preterm infants in first three days
- Factitious hyperkalaemia needs to be excluded before treatment
- Discuss with the Consultant if significant hyperkalaemia exists and treatment indicated

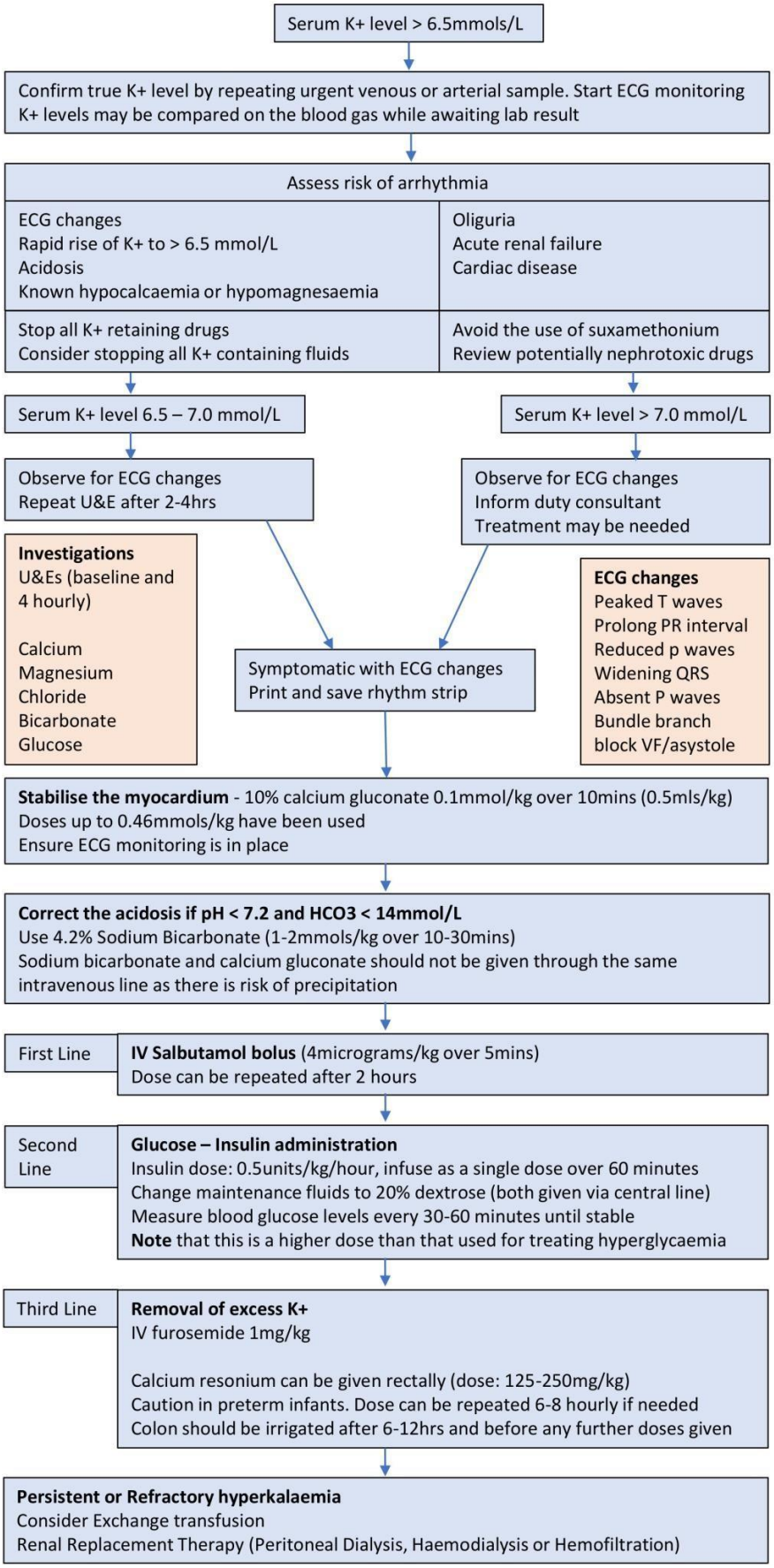
Aims

1. To monitor for significant hyperkalaemia in at risk infants
2. To use a graded-response strategy in the treatment of hyperkalaemia
3. To prevent the development of complications (arrhythmia) through monitoring and prompt treatment

Background [1,3,4]

The normal range of serum potassium levels in the newborn is 3.5 – 6.0mmol/L. Hyperkalaemia is usually defined as a serum potassium level of >6.5 mmol/L. Hyperkalaemia is a potentially life-threatening condition, which if untreated can lead to arrhythmias and death. It is most commonly seen in extremely preterm infants with impaired renal function. Serum potassium levels usually peak at around 24 hours after birth, and return to normal values by 72 hours of age. However, hyperkalaemia can occur without significant renal impairment due to release of potassium from catabolised cells, and shift of intracellular potassium ions into the extracellular space. Other proposed theories for the rise in serum potassium include immaturity of the renal tubular mechanisms for potassium secretion and a reduced glomerular filtration rate. It is also of note that antenatal steroid therapy appears to reduce the incidence of non-oliguric hyperkalaemia in ELBW infants.

Management of Hyperkalaemia flowchart



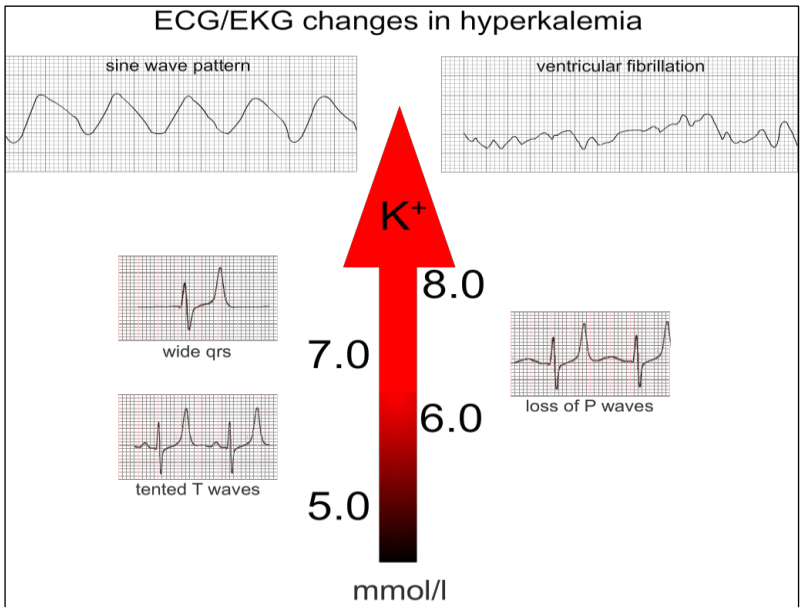
Incidence and risk factors

Hyperkalaemia is common in infants born at <28 weeks gestation. Risk factors for hyperkalaemia include:

- Extreme prematurity
- Oral or parenteral K^+ supplementation
- Low systemic blood flow leading to metabolic acidosis
- Acute renal failure (e.g. after perinatal asphyxia)
- Haemolysis & cell necrosis
- Sepsis
- Double volume exchange transfusion (due to "old blood")
- Chronic renal failure, Addisons's disease & 21-Hydroxylase deficiency
- Drugs - β-blockers, succinylcholine (suxemethonium) & K^+ sparing diuretics

Complications

Cardiac arrhythmias:



ECG changes in hyperkalaemia

- K+ levels > 6.5 mmols/L: tall, peaked T-waves, widening of the QRS complex,
- K+ levels > 8.0 mmols/L: shortened QT interval, prolonged PR interval, further widening of QRS complexes
- K+ levels > 9.0 mmols/L: absent p-waves, ventricular arrhythmias, sine wave and cardiac arrest.

The reported mortality of neonates with hyperkalaemia is high even with treatment [1]

Diagnosis

1. Infants who are at risk of hyperkalaemia should have serum potassium levels taken early and then at regular intervals.
2. Haemolysis e.g. in a “squeezed” heelprick sample can give a falsely elevated result. Therefore, blood should be taken from an arterial line or free-flowing venepuncture.
3. If a high serum K^+ (>6.5mmol/L) is reported, a further sample should be sent to the biochemistry laboratory, with the request being marked as urgent.
4. It can also be useful to note the trend in K^+ recorded from the blood gas analyser.
5. Check the urine output and exclude other causes of hyperkalaemia
6. The ECG trace on the monitor should also be checked regularly, looking for abnormally peaked T-waves, widened or abnormal QRS complexes. If these changes are present, immediate action would be needed

Principles of treating Hyperkalaemia [4,5,6,7]:

- Ensure serum potassium is truly elevated and not a false positive result due to haemolysed sample.
- **Stop administration of potassium immediately**. Stop potassium retaining drugs. Review nephrotoxic drugs.
- **Look for ECG changes:** tall and tenting of ‘T’ wave, wide QRS complex, flattening of ‘P’ wave and cardiac arrhythmias. ECG changes indicate myocardial excitability. Continuous ECG monitoring is needed during treatment.
- **Stabilise the myocardium:** Prevent or treat already established myocardial excitability by giving calcium gluconate.
- **Increase cellular uptake of potassium** by medications in order of preference:
  - Sodium bicarbonate – if there is acidosis
  - IV Salbutamol
  - Glucose & Insulin (bolus or infusion)
    (More than one medication may need to be given)
- **Removal of excess potassium:** Furosemide and Calcium resonium.
- In **refractory conditions**: Exchange transfusion, Peritoneal dialysis Haemodialysis and Haemofiltration.

Prevention or treatment of established myocardial irritability

- 10% Calcium gluconate: 0.1mmol/kg (0.5ml/kg) IV over 10 minutes. However, doses up to 0.46mmol/kg (2ml/kg) have been used.
- Onset of action: within 5 minutes.
- Calcium should be given with ECG monitoring. Print or save the rhythm for evidence and document in clinical notes.
- This will not reduce the potassium concentration.

Medications to increase intracellular shift of potassium

1. Sodium bicarbonate

- 4.2% sodium bicarbonate: 1 - 2 mmol/kg IV over 10-30 minutes.
- Onset of action: within 1 hour.
- It may be given, even when there is no acidosis.
- It is equally effective as glucose-insulin infusion.
- Preparations of sodium bicarbonate and calcium salts should not be administered in the same line - risk of precipitation.

2. Salbutamol

- Salbutamol: 4microgram/kg IV over 5 minutes.
- Onset of action: within 5 minutes.
- This should reduce the K^+ level by 1mmol/l.
- The dose can be repeated after 2 hours.
- Nebulised Salbutamol is **NOT** used in the neonatal unit.

3. Glucose –insulin [2, 7]

- Add 10 units/kg of soluble insulin to 50mls of 10% dextrose (double strength solution).
- From that give 0.5units/kg/hour = 2.5ml/hour **single dose infused** over 60 minutes [7].
- **Note** that this is a higher dose than used for treating hyperglycaemia.
- Change maintenance fluids to 20% dextrose given via a central line. This can be titrated according to blood sugars.
- Monitor blood glucose levels closely - initially ½ to 1 hourly until stable and also when weaning the infusion (insulin persists longer than dextrose).
- Onset of action: within 15 minutes.
- Needs to be given via a central line.
- Can be used even in very extreme preterm neonate.

Removal of excess potassium

1. Furosemide

- Intravenous furosemide (1mg/kg) can be given but is less effective in children with renal impairment.

2. Chelation therapy

- Calcium resonium can be given rectally (dose: 125-250mg/kg).
- Dose can be repeated 6-8 hourly if needed. Colon should be irrigated before any further doses are given and after 6-12hrs of treatment completion.
- This is a slow acting ion exchange resin, which should be used cautiously, as there is the potential complication of rectal impaction, bowel irritability, concretions, bleeding and perforation especially in preterm neonates.
- Should be discontinued as soon as safely possible.

Refractive hyperkalaemia

- Consider salbutamol infusion
- Exchange transfusion with freshly washed packed red cells, reconstituted with plasma.
- Peritoneal dialysis, Haemodialysis, Hemofiltration (may be limited by the time involved in transfer and preparation)

References / Other readings

1. Leslie GI, Carman G Arnold JD. Early neonatal hyperkalaemia in the extremely premature newborn infant. J Paediatr Child Health 1990; 26: 58-61
2. Lui K, et al. Treatment with hypertonic dextrose and Insulin in severe hyperkalaemia of immature infants. Acta Paediatrica 2008; 81(3): 213-216
3. Fetal and Neonatal Physiology; WB Saunders, 3rd edition
4. Roberton's textbook of Neonatology
5. LANGE Clinical Manual of Neonatology, 5th edition
6. BNF for children 2019
7. Neonatal Formulary 7th edition

Audit standards

- Documented evidence of high potassium results rechecked immediately and acted upon if truly elevated >6.5mmols/L (100%)

Guideline Development

Sept 2010	Neonatal Guidelines Meeting (new guideline)
Jan 2016	Reviewed by author (AOA) – no change to evidence / guidance
Jan 2016	Neonatal Governance Meeting
March 2019	Review by authors – SM and KDY
April 2019	Neonatal Guidelines Meeting
May 2019	Neonatal Governance Meeting