Electrolytes: monitoring and supplementation in critical care

Barts Health Critical Care Educators

Electrolytes:
What are they and how do we monitor them.

Main Electrolytes:

Sodium (Na+)
Potassium (K+)
Calcium (Ca+)
Phosphate (PO4)
Magnesium (MgSO4)

- ❑ Measured and supplemented daily while on critical care
- ❑ Daily Lab -Bloods U&E's
- ❑ Post op Lab Bloods
- ❑ Some can be monitored through point of care testing (ABG/VBG): Na, K, Ca
- ❑ Always check if a sudden deterioration occurs

K+ abnormalities

Hyperkalaemia
(>5.5 mmol/L)

- ❑ Nausea
- ❑ Vomiting
- ❑ Paralysis
- ❑ Muscle fatigue
- ❑ Weakness
- ❑ Abnormal heart rhythms → cardiac monitor if K+>6.0

Hypokalaemia
(< 3.5 mmol/L)
Supplement PO/NG/IV

- ❑ Fatigue
- ❑ Constipation
- ❑ Frequent urination or urinating large amounts
- ❑ Muscle cramps or skin tingling
- ❑ Muscle weakness
- ❑ Fast or irregular heartbeat

Hyperkalaemia Cardiac Changes

Hyperkalaemia is defined as a potassium level > 5.5 mEq/L

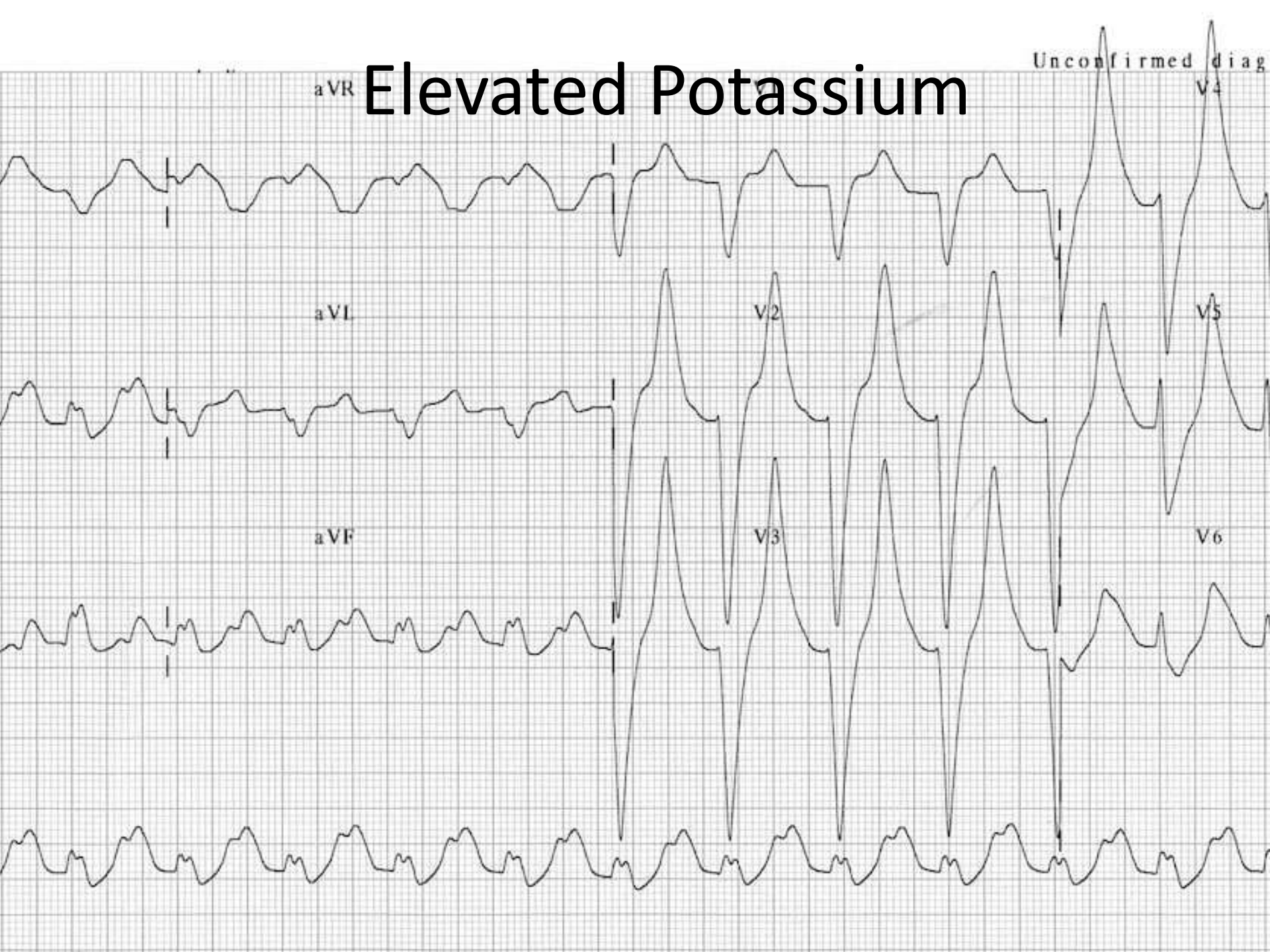
Moderate hyperkalaemia is a serum potassium > 6.0 mEq/L

Severe hyperkalaemia is a serum potassium > 7.0 mE/L

ECG changes in hyperkalaemia – this are an emergency and K+ needs to be lowered

- Peaked T waves
- Prolonged PR segment
- Loss of P waves
- Bizarre QRS complexes
- Sine wave
- Bradycardia

Elevated Potassium



Potassium (K+)

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Why is it low?

- Reduced intake
- Poor absorption- D &V
- Excessive NG loss
- Medicines, such as diuretics, blood pressure medicines, or antibiotics
- Excessive use of laxatives
- Anorexia or bulimia nervosa
- Medical conditions, such as Cushing syndrome or kidney disease

Why is it high?

- Excessive in take / dehydration
- Addison's disease (adrenal insufficiency)
- (ACE) inhibitors & Beta blockers
- Destruction of RBC's due to severe injury or burns
- Excessive use of potassium supplements
- Type 1 diabetes
- Renal failure
  - Acute
  - Chronic
  - Rhabdomyolisis

Hypokalaemia

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- Hypokalaemia is defined as a potassium level < 3.5 mmol/L
- Moderate hypokalaemia is a serum level of < 3.0 mmol/L
- Severe hypokalaemia is defined as a level < 2.5 mmol/L

ECG changes likely when K+ < 2.7 mmol/l

- Frequent supraventricular and ventricular ectopics
- Supraventricular tachyarrhythmias: AF, atrial flutter, atrial tachycardia
- Potential to develop life-threatening ventricular arrhythmias, e.g. VT, VF and Torsades de Pointes

Na+ abnormalities

Symptoms of Low Na+

Severity of symptoms associated with rapidity of loss and extent of fall

- >125 Asymptomatic
- 115-125 Lethargy, confusion, anorexia, nausea, vomiting
- <115 Muscle cramps and weakness, convulsions, coma

Symptoms of High Na+

>350: Excessive thirst

>375: Weakness and lethargy. Irritability

>400: Ataxia, tremor

>420: Focal neurological deficit; Hyperreflexia and Spasticity

>430: Coma and seizures

Sodium (Na+)

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Why is it low? (Hyponatraemia)

- Excessive fluid intake
- Neurological Conditions
- Cerebral salt wasting
- Addison's
- Renal failure
- (Diuretic stage)Salt losing nephropathy (RTA)
- Diuretic- Thiazides and osmotic diuretics

Why is it high?

- Poor fluid intake/Dehydration/H2O loss
- Excessive Salt intake (Fluid/food/drugs)
- GI loss
- Intrinsic renal disease
- Hypercalcaemia
- Hypokalaemia
- Diabetes Insipidus
- Glucosuria

Ca+ abnormalities

Normal serum corrected calcium = 2.2 – 2.6 mmol/L
Mild-moderate hypocalcaemia = 1.9 – 2.2 mmol/L
Severe hypocalcaemia = < 1.9 mmol/L

Hypocalcaemia

- ❑ Neuromuscular excitability
- ❑ Seizures
- ❑ Numbness
- ❑ Muscle spasms
- ❑ Seizures
- ❑ Confusion
- ❑ Cardiac arrest

Hypercalcaemia

- ❑ ECG changes
- ❑ N&V
- ❑ Drowsiness.
- ❑ Passing large amounts of urine.
- ❑ Dehydrated.
- ❑ Confusion or agitation

Calcium (Ca+)

Why is it low

- ❑ Hypoparathyroidism
- ❑ Vitamin D deficiency
- ❑ Acute pancreatitis
- ❑ Hyperphosphataemia
- ❑ Hypomagnesaemia
- ❑ Diuretics (frusemide)
- ❑ Pseudohypoparathyroidism
- ❑ Critical illness (e.g. sepsis)

Why is it high

- ❑ Hyperparathyroidism (primary and tertiary)
- ❑ Myeloma
- ❑ Bony metastases
- ❑ Sarcoidosis
- ❑ Excess vitamin D (e.g. iatrogenic)

Phosphate (PO4+)

Hypophosphatemia

- Precipitation of Ca2+
- Interference with parathyroid hormone
- Decreased vitamin D levels
- Muscle cramping
- Tetany
- Hyperreflexia
- Seizures
- ECG changes

Hypophosphatemia

- SOB
- Ventilator dependence
- Weakness
- Altered mental state
- Heart failure symptoms
- Shock

Phosphate(PO4+)

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Why is it low?

- **Intake:** malnutrition, Phosphate binders, vitamin D, malabsorption, TPN
- **Redistribution:** refeeding syndrome, insulin in DKA
- **Output:**
  - Urinary – diuretics, osmotic diuresis
  - Lower GI – diarrhoea
  - Sweating, burns, sepsis, bleeding

Why is it high?

- Renal failure
- Increased renal resorption
- Cellular injury with release (tumour lysis syndrome, rhabdomyolysis, haemolysis, ischemic gut)
- Medication related: phosphate containing laxatives, excessive administration, bisphosphonate therapy

Magnesium abnormalities

Low

- Arrhythmias
- Hypertension
- Constipation
- Muscle and nerve dysfunction (cramps/twitches)
- Headache
- Bronchospasm
- Sensory overload (bright lights/noise)

High

- Irregular heart-beat (arrhythmia)
- Low blood pressure (hypotension)
- Low heart rate (bradycardia)
- Skin flushing
- Difficult or slow breathing
- Muscle weakness
- Nausea
- Vomiting
- Facial paresthesia
- Decreased tendon reflexes

Magnesium

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High

- ❑ Kidney Failure
- ❑ Depression
- ❑ Haemolytic anaemia
- ❑ Addison disease
- ❑ Hypothyroidism

Low

- ❑ Alcohol use
- ❑ Burns that affect a large area of the body
- ❑ Chronic diarrhoea
- ❑ Polyuria uncontrolled diabetes and during recovery from acute kidney failure
- ❑ Hyperaldosteronism
- ❑ Kidney tubule disorders
- ❑ Malabsorption syndromes
- ❑ Malnutrition
- ❑ Medicines
- ❑ Pancreatitis
- ❑ Excessive sweating

Electrolyte supplementation

Use Trust guidelines for administration

If the electrolyte level is very low top up IV

→Warning- If urine output is low give lower doses to avoid accumulation of electrolytes

→Warning – if hypothermic and warming this may increase K+

Note different administration rates for central and peripheral routes.