



# NOTES

## HYPERKALEMIA & HYPOKALEMIA

### GENERALLY, WHAT ARE THEY?

#### PATHOLOGY & CAUSES

- Imbalances of potassium levels in blood
- Etiologies influence potassium intake, excretion, transcellular shift

#### SIGNS & SYMPTOMS

- Mild variations usually asymptomatic, severe imbalances may be fatal

#### DIAGNOSIS

#### LAB RESULTS

- Blood potassium levels; further tests useful to establish underlying cause

#### TREATMENT

#### MEDICATIONS

- Discontinue medication that aggravates potassium homeostasis
- Low serum  $K^+$ 
  - Oral  $K^+$  can be supplemented
- High serum  $K^+$ 
  - Agents/procedures that remove extracellular  $K^+$ , into cells/↑ secretion from body

## HYPERKALEMIA

[osms.it/hyperkalemia](https://osms.it/hyperkalemia)

#### PATHOLOGY & CAUSES

- High potassium levels in blood > 5.5 milliequivalents/liter (mEq/L)

#### CAUSES

##### Decreased kidney excretion

- Decreased glomerular filtration rate in acute/chronic kidney disease
- Adrenal insufficiency → primary hypoadosteronism
  - Principal cells secrete less potassium
- Drugs

- Renin inhibitors, angiotensin converting enzyme (ACE) inhibitors, angiotensin II receptor antagonists, potassium-sparing diuretics, nonsteroidal anti-inflammatory drugs (NSAIDs), cyclosporine, trimethoprim-sulfamethoxazole

##### Transcellular shift

- Uncontrolled Type I diabetes
  - Lack of insulin → decreases sodium/potassium pump action
- Acidosis
  - Excess hydrogen ions move into cells via ion transporters that exchange hydrogen ions for potassium ions
  - Respiratory acidosis; metabolic acidosis

from organic acids are two exceptions

- **Hyperosmolarity**
  - Gradient pulls water out of cells → intracellular concentration potassium goes up → potassium pushed out
- **Massive cell lysis**
  - E.g. tumor lysis syndrome, rhabdomyolysis, massive hemolysis
  - Intracellular potassium released into bloodstream (98% of  $K^+$  found within cells)
- **Drugs**
  - Beta2-adrenergic antagonists, digoxin toxicity
- **Exercise**
  - Cellular ATP consumed → potassium channels open
  - Shift usually small, can exacerbate condition in individuals with hyperkalemia

#### Increased intake

- Excessive potassium oral intake
  - Unusual, can exacerbate condition in individuals with hyperkalemia
- Rapid, excessive potassium infusion (rare)

### SIGNS & SYMPTOMS

- Mostly asymptomatic
- Severe/rapid-onset hyperkalemia
  - Muscle weakness, flaccid paralysis (starts in lower extremities, moves upward) → respiratory failure
  - Decreased deep tendon reflexes
  - Arrhythmias, cardiac arrest
  - Nausea, vomiting, intestinal colic, diarrhea



#### MNEMONIC: MURDER

##### Signs & symptoms of Hyperkalemia

**M**uscle weakness

**U**rine: oliguria, anuria

**R**espiratory distress

**D**ecreased cardiac contractility

**E**KG changes: peaked T waves; QRS widening

**R**eflexes: hyperreflexia or areflexia (flaccid)

### DIAGNOSIS

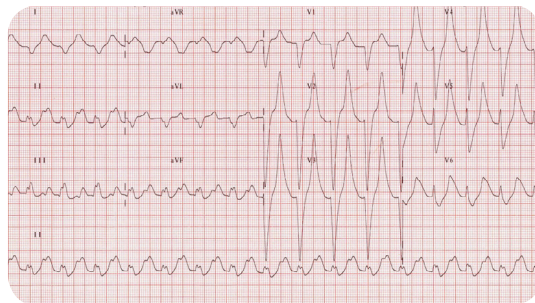
#### LAB RESULTS

- Potassium levels in blood > 5.5mEq/L

#### OTHER DIAGNOSTICS

##### ECG

- Prolonged PR interval, tall, peaked T-waves with narrow base, shortened QT interval, depressed ST segment
- Severe
  - Small/indiscernible P wave, widened QRS complex → strip mimics sine wave



**Figure 112.1** An ECG demonstrating the changes of hyperkalemia, including elevated T waves, bizarre, broad QRS complexes and a prolonged QT interval.

## TREATMENT

### MEDICATIONS

- Initial treatment (individuals with ECG changes)
  - Calcium to stabilize myocardial cell membranes

- Insulin with dextrose + beta2-adrenergic agonists
  - Increase potassium shift into cells
- Kayexalate
  - Bind potassium → decrease potassium absorbed from gastrointestinal (GI) tract
- Loop diuretics
  - Increase potassium excretion in kidneys



### MNEMONIC: C BIG K DROP

#### Treatment of Hyperkalemia

Calcium gluconate

Beta 2 agonist

Insulin + Glucose

Kayexalate

Diuretics/Dialysis

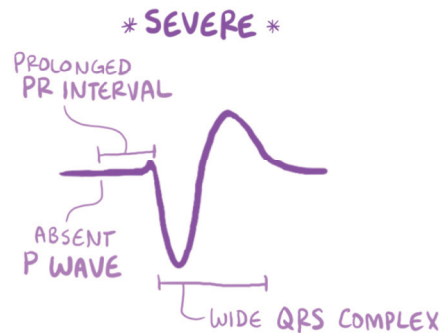
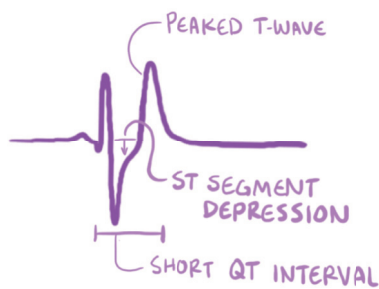
### OTHER INTERVENTIONS

- Severe hyperkalemia/renal failure
  - Hemodialysis (most rapid, effective way to lower serum  $K^+$ )

## DIAGNOSIS

\*  $\uparrow [K^+]$  in BLOOD  $\sim > 5.5 \text{ mEq/L}$

### \* ELECTROCARDIOGRAM



**Figure 112.2** The ECG features found in hyperkalemia.

# HYPOKALEMIA

osms.it/hypokalemia

## **PATHOLOGY & CAUSES**

- Low potassium levels in the blood < 3.5mEq/L

### **CAUSES**

- Increased kidney excretion
  - **Hyperaldosteronism**; drugs (e.g. loop, thiazide diuretics, amphotericin B, cisplatin); renal tubular defects (e.g. Bartter syndrome); hypomagnesemia
- Increased gastrointestinal excretion
  - Vomiting (direct losses minimal, causes metabolic alkalosis); diarrhea
- Increased sweat production
  - Relevant for individuals who exercise in hot climate
- Shift from extracellular to intracellular space
  - **Insulin overdose in Type I diabetes**; excess insulin → increases sodium/potassium pump action
- **Alkalosis**
  - **Hydrogens move out of cells** using ion transporter that exchanges with potassium ions
  - **Respiratory alkalosis** an exception
- **Drugs**
  - **Beta2-adrenergic agonists**

### **Other causes**

- Low dietary intake (e.g. prolonged fasting, anorexia, ketogenic diet)
- **Insulin administration**
- Antibiotics (TMP-SMX/amphotericin B)
- Epinephrine (beta 2-agonists)
  - Slightly more than half of trauma cases present with hypokalemia (increased epinephrine levels)

## **SIGNS & SYMPTOMS**

- Mostly asymptomatic
- Severe/rapid-onset hypokalemia
  - Constipation, paralytic ileus
  - Muscle weakness, cramps, flaccid paralysis
  - Decreased deep tendon reflexes
  - Arrhythmias (prolong cardiac conduction), cardiac arrest
  - Polyuria, polydipsia, nausea, vomiting
  - Exacerbates digitalis toxicity

## **DIAGNOSIS**

### **LAB RESULTS**

- Blood potassium level < 3.5mEq/L

### **OTHER DIAGNOSTICS**

#### **ECG**

- Flattened/inverted T waves, U waves, ST depression, prolonged PR interval
  - Prominent U waves fused to T waves, mimic prolonged QT
- Atrial, ventricular tachyarrhythmias

## **TREATMENT**

### **MEDICATIONS**

- Replenish potassium with supplementation
  - In acute coronary ischemia, active arrhythmias
- Oral KCl administration (safest)
- IV administration for individuals taking nil per os
  - 10mEq KCl increases K<sup>+</sup> by 0.1mEq/L
- Magnesium replacement
- If diuretic therapy needed
  - Potassium-sparing diuretic