

Hypokalemia & Hyperkalemia

Normal potassium level in the blood= 3.5-5 mEq/L

Hypokalemia= <3.5 mEq/L

Hyperkalemia= >5 mEq/L

Potassium

Potassium is regulated mainly by the hormone **aldosterone** which is secreted by the kidneys.

When potassium is high, aldosterone causes **more** potassium to be excreted in the urine. And when potassium is low, aldosterone secretion is decreased, therefore **less** potassium is signaled to be excreted in the urine.

As you can likely extrapolate from this information, urine is the main way that potassium is excreted from the body. There is also a small amount that is excreted in stool and sweat.

The main function that you should focus on when studying potassium, is its role in **excitable cells** such as neurons and muscle fibers (smooth, cardiac, and skeletal).

Potassium is an essential element in **action potentials** (or impulses) in these excitable cells. Therefore, potassium plays a key role in nerve conduction and muscle contractility.

Potassium also plays a role in maintaining intracellular fluid volume, pH balance, and protein synthesis.

Hypokalemia	Hyperkalemia
Lab value= <3.5 mEq/L	Lab value= >5 mEq/L
Causes: <ul style="list-style-type: none"> - Potassium depleting diuretics - Hyperaldosteronism - Vomiting & diarrhea - Kidney disorders - Alkalosis 	Causes: <ul style="list-style-type: none"> - Potassium sparing diuretics - Addison's Disease/hypoaldosteronism - Kidney failure - Tissue damage, burns - Acidosis
Signs/symptoms: <ul style="list-style-type: none"> - Hyporeflexia, generalized weakness (severe=flaccid paralysis) - Decreased respiratory effort - Decreased intestinal peristalsis - Dysrhythmias - AMS- irritability/anxious 	Signs/symptoms: <ul style="list-style-type: none"> - Muscle twitching>>weakness>>flaccid paralysis - Increased intestinal peristalsis - Dysrhythmias - Paresthesia
Treatment: <ul style="list-style-type: none"> - Oral or IV potassium supplementation (depending on severity) - Potassium sparing diuretic (if a diuretic is needed) 	Treatment: <ul style="list-style-type: none"> - Kayexalate - IV insulin + glucose - Potassium depleting diuretic (if kidneys are functioning)

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| | <ul style="list-style-type: none">- Dialysis (if severe and kidneys are not working)- Calcium gluconate |
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Nursing Considerations

The cardiac manifestations of both hypokalemia and hyperkalemia can be fatal. It is important to **monitor cardiac function closely** by ensuring telemetry has been initiated. If a patient is receiving IV potassium, then also be mindful of the potential cardiac alterations that could occur.

IV potassium should never be given IV push. IV potassium will always be an **infusion** that is diluted and given over a period of time. Administering IVP potassium could cause cardiac arrest and death.

IV potassium infusions are preferably administered into a central line. Potassium is a severe tissue irritant, so if it is being infused into a peripheral line, the IV insertion site should be assessed frequently. Patients may complain of burning at the IV insertion site during the infusion if being infused into a peripheral line.

Before administering IV potassium ensure the patient has **adequate urine output**. Do not infuse IV potassium if the patient is not urinating. This could cause severe hyperkalemia.

If a patient is given an oral potassium supplement, then be sure to educate them on the potential development of GI upset. To prevent GI upset from occurring, teach the patient to take their oral potassium **during or after a meal**.

Hypocalcemia and Hypercalcemia

Calcium normal lab value= 9-10.5 mg/dL

Calcium helps maintain bone strength and density, allows nerve impulse transmission, and is important in blood clotting

Calcium and phosphorous have an inverse relationship

When calcium levels are low, parathyroid hormone is secreted by the parathyroid

- Calcium is pulled from bone storage and placed in bloodstream
- Vitamin D absorption is stimulated
- Kidney excretion of calcium is inhibited

When calcium levels are high, thyrocalcitonin is secreted by the thyroid

- Bone resorption is inhibited
- Vitamin D absorption is inhibited
- Kidney excretion of calcium is promoted

Hypocalcemia	Hypercalcemia
Lab value= <9 mg/dL	Lab value= >10.5 mg/dL
Causes: <ul style="list-style-type: none"> - Dietary/ malabsorption - Parathyroid removal, hypoparathyroidism - Vitamin D deficiency - Polyuric phase in kidney failure - Calcium chelators - End stage kidney disease 	Causes: <ul style="list-style-type: none"> - Hyperparathyroidism - Vitamin D excess - Thiazide diuretics - Malignancy - Immobility - Dehydration
Signs/symptoms: <ul style="list-style-type: none"> - Hyperactive DTRs, muscle spasms, muscle twitching - Trousseau's sign, Chvostek's sign - Increased intestinal peristalsis (diarrhea, abdominal cramping) - ECG changes (prolonged ST interval, prolonged QT interval) - Decreased heart rate, hypotension - Paresthesia - Brittle, fragile bones - Seizures 	Signs/symptoms: <ul style="list-style-type: none"> - Hypoactive DTRs, severe muscle weakness - Decreased intestinal peristalsis (constipation, N/V, abdominal pain) - ECG changes (shortened ST segment, widened T wave) - Cardiac alterations- early= increased heart rate; severe, late= depressed cardiac electrical conduction= decreased heart rate and potential cardiac arrest), increased blood pressure - Impaired blood flow (cyanosis, pallor, decreased capillary refill) - Altered LOC- lethargy coma

Treatment: <ul style="list-style-type: none">- Phosphate binders (Renagel)- Oral and IV calcium replacement- Magnesium sulfate (if severe neuromuscular manifestations)	Treatment: <ul style="list-style-type: none">- Calcium chelators (Methracin, Cuprimine)- Rehydration- IV NS 0.9%- Furosemide (if diuretic is indicated)- Dialysis (if severe)
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Nursing Considerations:

Seizures precautions for hypocalcemia

- Quiet room with dim lights, keep noise to a minimum
- Oxygen and suction at bedside
- IV access
- Bed in lowest position, mattress on floor beside the bed

Infuse IV calcium slowly, patient should be on cardiac monitoring

Menopausal women are at an increased risk for hypocalcemia, therefore may experience brittle and fragile bones. All patients with hypocalcemia should be handled with care during repositioning, transferring, and ambulating. They are at increased risk of sustaining a fracture if injury were to occur.

Hypomagnesemia & Hypermagnesemia

Normal magnesium lab level = **1.3-2.1 mEq/L**

Magnesium is a mineral that is mostly (~60%) stored in the bone and cartilage.

Magnesium is regulated by the kidneys and intestines.

Magnesium is a membrane stabilizer and has an important role in the following:

- Skeletal muscle contraction
- Blood coagulation
- Carbohydrate metabolism
- Cell growth

Hypomagnesemia	Hypermagnesemia
Lab value= <1.3 mEq/L	Lab value= >2.1 mEq/L
<p>Causes:</p> <ul style="list-style-type: none"> - Malnutrition/Dietary - Intestinal disease-Celiac, Crohn's - Alcoholism 	<p>Causes:</p> <ul style="list-style-type: none"> - Dietary (too much magnesium intake-antacids) - IV magnesium infusion - Kidney disease
<p>Signs/symptoms:</p> <ul style="list-style-type: none"> - Hyperactive DTRs, painful muscle contractions, tetany - Chvostek's and Trousseau's sign - Seizures - Psychological alterations - Paresthesia - Decreased intestinal peristalsis, constipation 	<p>Signs/symptoms:</p> <ul style="list-style-type: none"> - Hypoactive or absent DTRs, muscle weakness - Bradycardia, vasodilation, hypotension - Drowsy/lethargic - ECG changes- prolonged PR interval, widened QRS complexes - Decreased respiratory rate
<p>Treatment:</p> <ul style="list-style-type: none"> - IV magnesium (MgSO₄) - Oral magnesium 	<p>Treatment:</p> <ul style="list-style-type: none"> - IV fluids - Loop diuretics- Lasix - IVP calcium gluconate - Dialysis

Nursing Considerations:

Implement seizure precautions for patients with hypomagnesemia

- Quiet room with dim lights, keep noise to a minimum
- Oxygen and suction at bedside
- IV access
- Bed in lowest position, mattress on floor beside the bed

Assess kidney function of a patient receiving IV magnesium. If the patient has a decreased in urinary output during the infusion, the infusion should be stopped; severe hypermagnesemia could occur if the infusion continues running.

Assess DTRs hourly in a patient who is receiving IV magnesium to ensure that hypermagnesemia does not result. If DTRs become weakened or absent stop the infusion and notify the physician.

Monitor cardiac function closely of a patient with hypermagnesemia. **HIGH** risk for cardiac arrest if severe levels. Ensure cardiac monitoring has been initiated.

Administer IVP calcium gluconate **slowly (5-10 minutes)** depending on the dose).

Hyponatremia & Hypernatremia

Sodium normal lab value= 135-145 mEq/L

Sodium level determines where water is located (where salt goes, water follows) This can cause water to be retained, excreted, or moved from one space to another

Sodium is important for the depolarization of excitable membranes that cause skeletal muscle contraction, cardiac contraction, and nerve impulse transmission

When sodium levels are low

- ADH and NP secretion is inhibited
- Aldosterone secretion is triggered

When sodium levels are high

- Aldosterone secretion is inhibited
- ADH and NP secretion is stimulated

Hyponatremia	Hypernatremia
Lab value= <135 mEq/L	>145 mEq/L
Causes: <ul style="list-style-type: none"> - Excessive diaphoresis - Diuretics - GI wound drainage - Psychogenic polydipsia - Nephrotic syndrome - SIADH - Heart failure 	Causes: <ul style="list-style-type: none"> - Vomiting, diarrhea - Cushing's disease - Hyperaldosteronism - Kidney failure - Diabetes insipidus - Hyperventilation
Signs/symptoms: <ul style="list-style-type: none"> - Behavioral changes, altered LOC - Generalized weakness, diminished DTRs - Increase intestinal motility- vomiting, diarrhea, abdominal cramping - Hypovolemic= rapid weak pulse, decreased blood pressure - Hypervolemic= full, bounding pulse, increased blood pressure 	Signs/symptoms: <ul style="list-style-type: none"> - Agitation, confusion, lethargy - Muscle twitching, muscle contractions (severe=absent DTRs, muscle weakness) - Hypovolemic= faint pulses, hypotension - Hypervolemic= bounding pulses, distended neck veins, increased blood pressure
Treatment: <ul style="list-style-type: none"> - DC diuretic therapy - IV saline solution (for fluid deficit) - Conivaptan, tolvaptan - Demeclocycline - Increased sodium intake 	Treatment: <ul style="list-style-type: none"> - Diuretics- Lasix, bumetanide - Hypotonic IV solution (0.225% NaCl) - Restrict sodium intake

Nursing Considerations

Monitor the respiratory system of individuals with **hyponatremia** and **severe hypernatremia** as they could experience respiratory failure due to severe muscle weakness.

Patients who receive hypotonic IV solutions should be monitored closely for **neurological changes**. Cerebral edema could occur due to the shift of volume into the cells.

Educate patients on foods that are high in sodium. Teach patients with hyponatremia to increase consumption of healthy foods that are high in sodium; teach patients with hypernatremia to restrict consumption of foods that are high in sodium.

Hypophosphatemia & Hyperphosphatemia

Normal phosphorus level= 3-4.5 mg/dL

Phosphorous is important in the following functions

- Activating vitamins and enzymes
- Forming ATP for energy supplies
- Cell growth and metabolism
- Calcium homeostasis

Phosphorus and calcium have an inverse relationship

Hypophosphatemia	Hyperphosphatemia
Lab value= <3 mg/dL	Lab value= >4.5 mg/dL
Causes: <ul style="list-style-type: none"> - Malnutrition - Hyperparathyroidism - Hypercalcemia - Malignancy - Alcohol abuse 	Causes: <ul style="list-style-type: none"> - Dietary - Hypoparathyroidism - Tumor lysis syndrome - Kidney disease
Signs/symptoms: <ul style="list-style-type: none"> - Decreased cardiac output, decreased stroke volume - Generalized weakness - Decreased respiratory effort - Emotional irritability - Seizures, coma (severe) - Decreased bone density 	Signs/Symptoms: *Refer to hypocalcemia information* Most dangerous symptoms associated with hyperphosphatemia are related to the effects of hypocalcemia
Treatment: <ul style="list-style-type: none"> - Oral phosphorous with vitamin D supplementation - Dietary- phosphorous rich foods such as animal sources (fish, beef, chicken, pork) and nuts - IV phosphorous (if severe) 	Treatment: *Refer to hypocalcemia information* Managing hyperphosphatemia involves management of hypocalcemia

Nursing Considerations:

Safety precautions should be put into place for individuals with hypophosphatemia as they are at an increased risk of experiencing a fracture.

Educate patients on foods that are high in phosphorous. Phosphorous rich foods include fish, beef, chicken, pork, and nuts. Individuals with hypophosphatemia should be encouraged to consume these foods, while patients with hyperphosphatemia should be taught to avoid such foods.

See nursing considerations for hypocalcemia