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PURE IONIC WATER™ SYSTEMS

Electrolytes

ELECTROLYTES

An electrolyte, according to the National Cancer Institute is a substance that breaks up into ions (particles with electrical charges) when it is dissolved in water or body fluids. Some examples of ions are sodium, potassium, calcium, chloride, and phosphate. These ions help move nutrients into cells, help move waste out of cells, and help nerves, muscles, the heart, and the brain work the way they should. They play essential roles in modulating and maintaining key life functioning, such as the functioning of the nerves, muscles, kidneys, GI tract and others.

In physiology, the primary ions of electrolytes are sodium (Na^+), calcium (Ca^{2+}), potassium (K^+), chloride (Cl^-), magnesium (Mg^{2+}), hydrogen phosphate (HPO_4^{2-}), and hydrogen carbonate (HCO_3^-). Sodium is the main electrolyte found in extracellular fluid and potassium is the main intracellular electrolyte; both are involved in fluid balance and blood pressure control.

In the next paragraphs, electrolytes roles, regulation, maintenance and consequences of electrolytes deficiencies will be discussed in detail:

Sodium

Sodium, which is an osmotically active cation, is one of the most important electrolytes in the extracellular fluid. It is responsible for maintaining the extracellular fluid volume, and also for regulation of the membrane potential of cells. Sodium is exchanged along with potassium across cell membranes as part of active transport.

Sodium regulation occurs in the kidneys. The proximal tubule is where the majority of sodium reabsorption takes place. In the distal convoluted tubule, sodium undergoes reabsorption. Sodium transport takes place via sodium-chloride symporters, which are by the action of the hormone aldosterone.

Among the electrolyte disorders, hyponatremia is the most frequent. Diagnosis is when the serum sodium level is less than 135 mmol/L. Hyponatremia has neurological manifestations. Patients may present with headaches, confusion, nausea, delirium. Hypernatremia presents when the serum sodium levels are greater than145 mmol/L. Symptoms of hypernatremia include tachypnea, sleeping difficulty, and feeling restless. Rapid sodium corrections can have serious consequences like cerebral edema and osmotic demyelination syndrome.

Potassium

Potassium is mainly an intracellular ion. The sodium-potassium adenosine triphosphatase pump has the primary responsibility for regulating the homeostasis between sodium and potassium, which pumps out sodium in exchange for potassium, which moves into the cells. In the kidneys, the filtration of potassium takes place at the glomerulus. The reabsorption of potassium takes place at the proximal convoluted tubule and thick ascending loop of Henle. Potassium secretion occurs at the distal convoluted tubule. Aldosterone increases potassium secretion. Potassium channels and potassium-chloride cotransporters at the apical membrane also secrete potassium.

Potassium disorders are related to cardiac arrhythmias. Hypokalemia occurs when serum potassium levels under 3.6 mmol/L—weakness, fatigue, and muscle twitching present in hypokalemia. Hyperkalemia occurs when the serum potassium levels are above 5.5 mmol/L, which can result in arrhythmias. Muscle cramps, muscle weakness, rhabdomyolysis, myoglobinuria are presenting signs and symptoms in hyperkalemia.

Calcium

Calcium has a significant physiological role in the body. It is involved in skeletal mineralization, contraction of muscles, the transmission of nerve impulses, blood clotting, and secretion of hormones. The diet is the predominant source of calcium. It is mostly present in the extracellular fluid. Absorption of calcium in the intestine is primarily under the control of the hormonally active form of vitamin D, which is 1,25-dihydroxy vitamin D3. Parathyroid hormone also regulates calcium secretion in the distal tubule of kidneys. Calcitonin acts on bone cells to increase the calcium levels in the blood.

Hypocalcemia diagnosis requires checking the serum albumin level to correct for total calcium, and the diagnosis is when the corrected serum total calcium levels are less than 8.8 mg/dl, as in vitamin D deficiency or hypoparathyroidism. Checking serum calcium levels is a recommended test in post-thyroidectomy patients. Hypercalcemia is when corrected serum total calcium levels exceed 10.7 mg/dl, as seen with primary hyperparathyroidism. Humoral hypercalcemia presents in malignancy, primarily due to PTHrP secretion.

Bicarbonate

The acid-base status of the blood drives bicarbonate levels. The kidneys predominantly regulate bicarbonate concentration and are responsible for maintaining the acid-base balance. Kidneys reabsorb the filtered bicarbonate and also generate new bicarbonate by net acid excretion, which occurs by excretion of both titrable acid and ammonia. Diarrhea usually results in loss of bicarbonate, thus causing an imbalance in acid-base regulation.

Magnesium

Magnesium is an intracellular cation. Magnesium is mainly involved in ATP metabolism, contraction and relaxation of muscles, proper neurological functioning, and neurotransmitter release. When muscle contracts, calcium re-uptake by the calcium-activated ATPase of the sarcoplasmic reticulum is brought about by magnesium. Hypomagnesemia occurs when the serum magnesium levels are less under 1.46 mg/dl. It can present with alcohol use disorder and gastrointestinal and renal losses—ventricular arrhythmias, which include torsades de pointes seen in hypomagnesemia.

Chloride

Chloride is an anion found predominantly in the extracellular fluid. The kidneys predominantly regulate serum chloride levels. Most of the chloride, which is filtered by the glomerulus, is reabsorbed by both proximal and distal tubules (majorly by proximal tubule) by both active and passive transport.

Hyperchloremia can occur due to gastrointestinal bicarbonate loss. Hypochloremia presents in gastrointestinal losses like vomiting or excess water gain like congestive heart failure.

Phosphorus

Phosphorus is an extracellular fluid cation. Eighty-five percent of the total body phosphorus is in the bones and teeth in the form of hydroxyapatite; the soft tissues contain the remaining 15%. Phosphate plays a crucial role in metabolic pathways. It is a component of many metabolic intermediates and, most importantly of adenosine triphosphate(ATPs) and nucleotides. Phosphate is regulated simultaneously with calcium by Vitamin D3, PTH, and calcitonin. The kidneys are the primary avenue of phosphorus excretion.

Phosphorus imbalance may result due to three processes: dietary intake, gastrointestinal disorders, and excretion by the kidneys. Read full article.

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