Electrolytes Overview

Electrolytes are the smallest of chemicals that are important for the cells in the body to function and allow the body to wok. Electrolytes such as sodium, potassium, and others are critical in allowing cells to generate electricity, contract muscles, move water and fluids within the body, and participate in myriad other activities.

The concentration of electrolytes in the body is controlled by a variety of hormones, most of which are manufactured in the kidney and the adrenal glands. Sensors in specialized kidney cells monitor the amount of sodium, potassium, and water in the bloodstream. The body functions in a very narrow range of normal, and it is hormones like rennin (made in the kidney), angiotensin (from the lung, brain and heart), aldosterone (from the adrenal gland), and antidiuretic hormone (from the pituitary) that keep the electrolyte balance within those normal limits.

Keeping electrolyte concentration in balance also includes stimulating the thirst mechanism when the body gets dehydrated.

Sodium (Na) (135-146)

Sodium is most often found outside the cell, in the plasma (the non-cell part) of the bloodstream. It is a significant part of water regulation in the body, since water goes where sodium goes. If there is too much sodium in the body, perhaps due to high salt intake in the diet (salt is sodium plus chloride), it is excreted by the kidney, and water follows.

Sodium is an important electrolyte that helps with electrical signals in the body, allowing muscles to fire and the brain to work. It is half of the electrical pump at the cell level that keeps sodium in the plasma and potassium inside the cell.

Hypernatremia (hyper = too much + natr = sodium + emia = in the blood) is usually associated with dehydration, and instead of having too much sodium, there is too little water. This water loss can occur from illness with vomiting or diarrhea, excessive sweating from exercise or fever, or from drinking fluid that has too high concentrations of salt.

Hyponatremia (hypo = too little) is caused by water intoxication (drinking so much water that It dilutes the sodium in the blood and overwhelms the kidney's compensation mechanism) or by a syndrome of inappropriate anti-diuretic hormone secretion (SIADH). SIADH can be associated with illnesses like pneumonia, brain diseases, cancer, thyroid problems, and some medications.

Symptoms of Sodium Imbalance

Too much or too little sodium can cause cells to malfunction. Lethargy, confusion, weakness, swelling, seizures, and coma are some symptoms that can occur with hyper-or Hyponatremia. The treatment of these conditions is dependent on the underlying cause, but it is important for the health care practitioner to understand the reason for abnormal flow of water into or out of cells. This is especially important to prevent brain cell damage (central pontinemyolysis)

Potassium (K)

Potassium is most concentrated inside the cells of the body. The gradient, or difference in concentration from within the cell compared to the plasma, is essential in the generation of the electrical impulses in the body that allow muscles and the brain to function.

Conditions of Potassium Imbalance (3.5-5.0)

Hyperkalemia (hyper = too much + kal = potassium + emia = in the blood) is a potentially life-threatening situation because it causes abnormal electrical conduction in the heart and potentially life-threatening heard rhythm problems. High potassium levels are most often associated with kidney failure, in which potassium levels build up cannot be excreted in the urine. Medications can be used to lower potassium levels until the kidneys are able to excrete the excess in the urine. However, emergency dialysis may be required to remove the potassium if kidney function is poor.

Hypokalemia (hypo = too little) is most often seen when the body loses too much potassium from causes like vomiting, diarrhea, sweating, and medications like diuretics or laxatives. It is often seen in diabetic ketoacidosis, where potassium is excessively lost in the urine. Since chemicals in the body are related in their metabolism, low magnesium levels can be associated with Hypokalemia.

calcitonin, which promotes bone growth and decreases calcium levels in the blood, and parathyroid hormone, which does the opposite. Calcium is bound to the proteins in the bloodstream, so the level of calcium is related to the patient's nutrition as well as the calcium intake in the diet. Calcium metabolism in the body is closely linked to magnesium levels. Often, the body's magnesium status needs to be optimized before the calcium levels can be treated.

Conditions of Calcium Imbalance (9.0-10.5)

Hypercalcemia (hyper = too much + calc = calcium + emia = in the blood) is associated with "moans, stones, abdominal groans"; symptoms include kidney stones, abdominal pain, and depression. Also, too much calcium can be associated with heart rhythm disturbances. Causes of hypercalcemia include parathyroid tumors, other tumors including breast cancer, excess amounts of Vitamin A or D, Paget's disease, and kidney failure.

Hypocalcemia (hypo = too little) is usually associated with eating disorders or lack of parathyroid hormone. Symptoms include weakness, muscle spasms, and heart rhythm disturbance.

Magnesium (Mg) (1.3-2.1 mEq/L)

Magnesium is an often forgotten electrolyte that is involved with a variety of metabolic activities in the body, including relaxation of the smooth muscles that surround the bronchial tubes in the lung, skeletal muscle contraction, and excitation of neurons in the brain. Magnesium acts as a cofactor in many of the body's enzyme activities.

Magnesium levels in the body are closely linked with sodium, potassium, and calcium metabolism; and are regulated by the kidney. Magnesium enters the body through the diet, and the amount of the chemical that is absorbed depends upon the concentration of magnesium in the body. Too little magnesium stimulates absorption from the intestine, while too much decreases the absorption.

Conditions of Magnesium Imbalance

Hypomagnesia, too little magnesium in the blood stream, may occur because of many reasons. Some have to do with dietary deficiencies, inability of the intestine to absorb the chemical, or due to increased excretion. Common causes of low magnesium include alcoholism and its associated malnutrition, chronic diarrhea, and medications like diuretics (water pills used to control high blood pressure). More than half of hospitalized patients in ICUs may become magnesium deficient.

Symptoms involve the heart with rhythm abnormalities, muscles with weakness and cramps, and the nervous system, potentially causing confusion, hallucinations, and seizures.

Hypermagnesia descries too much magnesium in the blood stream and most often occurs in patient with kidney function problems in which the excretion of magnesium is limited. In these patients, too much magnesium intake in the diet or from magnesium-containing medications like milk of magnesia or Maalox may cause elevated magnesium levels. Since the absorption and excretion of magnesium is linked to other electrolytes, other diseases may be associated with high magnesium levels, including diabetic ketoacisosis, adrenal insufficiency, and hyperparathyroidism. Hypermagnesia is often associated with hypocalcemia (low calcium) and hyperkalemia (high potassium).

Symptoms can include heart rhythm disturbance, muscle weakness, nausea and vomiting, and breathing difficulties.

Bicarbonate (HCO3) (22-26)

This electrolyte is an important component of the equation that keeps the acid-base status of the body in balance.

Water + Carbon Dioxide – Bicarbonate + Hydrogen

The lungs regulate the amount of carbon dioxide, and the kidneys regulate bicarbonate (HCO3). This electrolyte helps buffer the acids that build up in the body as normal byproducts of metabolism. For example, when muscles are working, they produce lactic acid as a byproduct of energy formation. HCO3 is required to be available to bind the hydrogen released from the acid to form carbon dioxide and water. When the body malfunctions, too much acid may also be produced (for example, diabetic ketoacidosis, renal tubular acidosis) and HCO3 is needed to try to compensate for the extra acid production.

Measuring the amount of bicarbonate in the blood stream can help the health care practitioner decide how severe the acid-base balance of the body has become.