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ELECTROLYTES PANEL

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ELECTROLYTES

Electrolytes is a chemical substance, when dissolved in water, dissociates into electrically charged particles (ions) and thus is capable of conducting an electric current. The principal positively charged ions in the body fluids (cations) are sodium (Na+), potassium (K+), calcium (Ca2+), and magnesium (Mg2+). The most important negatively charged ions (anions) are chloride (Cl−), bicarbonate (HCO3−), and phosphate (PO43−). These electrolytes are involved in metabolic activities and are essential to the normal function of all cells.

A-Sodium

Sodium is the most abundant cation (90% of the electrolyte fluid) and It is the major cation in the extracellular fluid (ECF). The essential functions of sodium are:

1- Maintain osmotic pressure 2- Acid-base balance 3-Transmit nerve impulses. 4- Maintaining systemic blood pressure

Kidney is responsible to maintain the sodium concentration and this process is governed by hormonal mechanisms recruited for maintaining a constant sodium level in the plasma and extracellular fluid include:

1- Natriuretic peptides (decrease sodium level) 2- Aldosterone hormone (increase sodium level 3- Antidiuretic hormone (ADH) to prevent water losses.

Another mechanism is the use of thirst. When the blood sodium increases, the person will feel thirsty, with the resulting intake of water helping to return the blood sodium to a normal level. The body requires only 1 to 2 mmol/day.

Methods for determining the serum sodium levels:

1- Atomic absorption spectrophotometry (AAS).

2- Flame emission spectrophotometry (FES).

3- Electrochemically with an Na+ (ISE).

4- Spectrophotometrically. (Major method which is used in clinical laboratory).

Normal Values: 135–145 mEq/L (135–145 mmol/L)

Clinical Implications:

****Hyponatremia** (decreased sodium levels): Reduced sodium levels are associated with the following:

1- Severe burns 2- Excessive fluid loss (e.g., severe diarrhea, vomiting, sweating) 3- Addison's disease (impairs sodium reabsorption) 4- Nephrotic syndrome 5- Edema (dilutional hyponatremia).

Hypernatremia (increased sodium levels): it is associated with the following conditions:

1- Dehydration and insufficient water intake. 2- Diabetes insipidus 3- Cushing disease. 4- Too much oral salt intake.

-Potassium:

Potassium is the principal electrolyte (cation) of intracellular fluid and the primary buffer within the cell itself. It is also present in small amounts in the extracellular fluid. There is an inverse relationship between potassium and sodium. Aldosterone enhances K+ secretion and Na+ reabsorption in the distal tubules by a Na+-K+ exchange mechanism

Potassium plays an important role in:

1- Nerve conduction 2- Osmotic pressure 3- Acid-base balance 4- Electrical conduction in muscle cells, especially cardiac and skeletal muscles.

Normal Values: 3.5–5.0 mEq/L (3.5–5.0 mmol/L SI units)

Clinical Implications:

****Decreased blood potassium (hypokalemia):**

1- Hyperaldosteronism 2- Prolonged diarrhea and vomiting 3- Malabsorption 4- Respiratory alkalosis.

****Increased potassium levels (hyperkalemia):**

1- Renal failure 2- Dehydration 3- Addison's disease 4- Acidosis.

Important notes:

1- EDTA tubes should not be used because it contains K+.

2- Avoid prolonged tourniquet or repeated clenching of the fist during venipuncture, which will increase the potassium value.

C- Chloride:

Chloride (Cl-) is the major anion of the extracellular fluid. Chloride levels have an inverse relationship with those of bicarbonate. Chloride has several functions include:

1- Maintaining electrical neutrality by counterbalancing cations such as sodium (NaCl, HCl). 2- Acting as one component of the buffering system 3- Aiding in digestion 4- Helping to maintain osmotic pressure and water balance.

Because chloride is most often seen in combination with sodium, shifts in sodium levels result in corresponding shifts in chloride levels.

Normal Values 96–106 mEq/L (96–106 mmol/L)

Clinical Implications:

****Decreased blood chloride levels (hypochloremia) occur in the following conditions:**

1- Severe vomiting 2- Hyponatremia 3- Chronic renal failure 4- Addison's disease

****Increased blood chloride levels (Hyperchloremia) occur in the following conditions:**

1- Dehydration 2- Hyperventilation 3- Cushing's syndrome 4- Prolonged diarrhea with the loss of sodium bicarbonate.

Important notes:

Chloride level may increase with using of ammonium chloride (used for treat metabolic alkalosis), while its level decrease with using thiazide diuretics.

D- Bicarbonate

Bicarbonate is an electrolyte, a negatively charged ion, Bicarbonate is part of the bicarbonate-carbonic acid buffering system and is mainly responsible for **regulating the pH of body fluids**. It also **facilitates the transport of carbon dioxide from the body tissues to the lungs**. **In the digestive tract, bicarbonate is secreted by the pancreas and liver into the duodenum to neutralize the acid chyme entering from the stomach.** Serum bicarbonate levels are approximated from the serum carbon dioxide level minus 1.2 mmol (the average concentration of carbonic acid).

Normal Values 22–26 mEq/L (22–26 mmol/L)

Clinical Implications:

Decreased level of bicarbonate can be seen in:

1- Metabolic acidosis 2- Starvation 3- Methanol poisoning

Increased level of bicarbonate can be seen in:

1- Excessive vomiting 2- Metabolic alkalosis 3- Ingestion of excessive amount of antacid, diuretics and steroids.

Practical part:

All electrolytes mentioned above are determined in the laboratory via spectrophotometric method using special kit for each one separately, but the general principle is same for all. The following steps will illustrate some of that:

1- In a right manner 5 ml or less of venous blood is withdrawal from the patient and transfer it for the right tube (most of tests in normal serum tube).

2- Do a centrifugation for the blood in order to get the serum or plasma as the test required or may be a whole blood without centrifugation.

3- Prepare the required kit and read the leaflet provided with the kit for understanding how much you will add from the reagents and the exact amount of the serum, plasma or whole blood you should take.

4- It is important to take the exact wavelength that this test working on, in order to set up the spectrophotometer on this wavelength and set it to zero absorption for measure your reagents.

5- Then record your results and do your calculations