An electrolyte includes most soluble salts, acids, and bases dissolved in water. Upon dissolving, the substance separates into cations and anions.

In physiology, the primary ions of electrolytes are sodium (Na+), potassium (K+), calcium (Ca2+), magnesium (Mg2+), chloride (Cl−), hydrogen phosphate (HPO42−), and hydrogen carbonate (HCO3−). The electric charge symbols of plus (+) and minus (−) indicate that the substance is ionic in nature and has an imbalanced distribution of electrons.

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.

All known multicellular life forms require electrolyte balance between the intracellular and extracellular environments. In particular, the maintenance of precise osmotic gradients of electrolytes is important. Such gradients affect and regulate the hydration of the body as well as blood pH, and are critical for nerve and muscle function. Various mechanisms exist in living species that keep the concentrations of different electrolytes under tight control.

Both muscle tissue and neurons are considered electric tissues of the body. Muscles and neurons are activated by electrolyte activity between the extracellular fluid or interstitial fluid, and intracellular fluid. Electrolytes may enter or leave the cell membrane through "ion channels". For example, muscle contraction is dependent upon the presence of calcium (Ca2+), sodium (Na+), and potassium (K+). Without sufficient levels of these key electrolytes, muscle weakness or severe muscle contractions may occur.

Electrolyte balance is maintained by oral, or in emergencies, intravenous (IV) intake of electrolyte-containing substances, and is regulated by hormones, in general with the kidneys flushing out excess levels. In humans, electrolyte homeostasis is regulated by hormones such as antidiuretic hormones, aldosterone and parathyroid hormones. Serious electrolyte disturbances, such as dehydration and over-hydration, may lead to cardiac and neurological complications and, unless they are rapidly resolved, will result in a medical emergency.

**Hyponatremia**

is a low sodium concentration in the blood. It is generally defined as a sodium concentration of less than 135 mmol/L (135 mEq/L), with severe hyponatremia being below 120 mEq/L. Symptoms can be absent, mild or severe. Mild symptoms include a decreased ability to think, headaches, nausea, and poor balance. Severe symptoms include confusion, seizures, and coma

Causes

The specific causes of hyponatremia are generally divided into whether the person has high fluid volume, low fluid volume.

1. **High volume state**

Both sodium and water intra vascular content increase: Increase in sodium content leads to hypervolemia and water content to hyponatremia. These includes

Cirrhosis of the liver

Congestive heart failure

Nephrotic syndrome in the kidneys

Excessive drinking of fluids

1. **Low volume**

Hypovolemia (extracellular volume loss) is due to total body sodium loss. Hyponatremia is caused by a relatively smaller loss in total body water.

Any cause of hypovolemia such as prolonged vomiting, decreased oral intake, severe diarrhea, Diuretic use , Pancreatitis.

**Treatment**

is based on the underlying cause**. Correcting hyponatremia too quickly can lead to complications. Rapid partial correction with 3% normal saline is only recommended in those with significant symptoms and those in whom the condition was of rapid onset**.

Low volume hyponatremia is typically treated with intravenous normal saline, high volume hyponatremia is typically treated with both fluid restriction and a diet low in salt

**Hypernatremia**

is a high concentration of sodium in the blood. Early symptoms may include a strong feeling of thirst, weakness, nausea, and loss of appetite. Severe symptoms include confusion, muscle twitching, and bleeding in or around the brain. Normal serum sodium levels are 135–145 mmol/L (135–145 mEq/L). Hypernatremia is generally defined as a serum sodium level of more than 145 mmol/L. Severe symptoms typically only occur when levels are above 160 mmol/L.

Causes includes excessive thirst sweating, diabetes insipidus and glycosuria.

The cornerstone of treatment is administration of free water to correct the relative water deficit. Water can be replaced orally or intravenously. Water alone cannot be administered intravenously (because of osmolarity issues leading to rupturing of red blood cells in the bloodstream), but rather can be given intravenously in solution with dextrose (sugar) or saline (salt). However, overly rapid correction of hypernatremia is potentially very dangerous. The body (in particular the brain) adapts to the higher sodium concentration. Rapidly lowering the sodium concentration with free water, once this adaptation has occurred, causes water to flow into brain cells and causes them to swell. This can lead to cerebral edema, potentially resulting in seizures, permanent brain damage, or death. Therefore, significant hypernatremia should be treated carefully by a physician or other medical professional with experience in treatment of electrolyte imbalance.

**Vasopressin** (AntiDiuratic Hormone)

Is a hormone released from posterior pitutary into the circulation in response to extracellular fluid hypertonicity (hyperosmolality). it has two primary functions. First, it increases the amount of solute-free water reabsorbed back into the circulation from the filtrate in the kidney tubules of the nephrons. Second, AVP constricts arterioles, which increases peripheral vascular resistance and raises arterial blood pressure.

**Diabetes insipidus (DI)**

is a condition characterized by large amounts of dilute urine and increased thirst. The amount of urine produced can be nearly 20 liters per day. Reduction of fluid has little effect on the concentration of the urine. Complications may include dehydration or seizures types includes

1. Central diabetes insipidus, also called neurogenic diabetes insipidus, is a type of diabetes insipidus due to a lack of vasopressin (ADH) production in the brain. Vasopressin acts to increase the volume of blood (intravascularly), and decrease the volume of urine produced. Therefore, a lack of it causes increased urine production and volume depletion. Causes includes
2. 25% Unknown
3. Benign suprasellar tumors (20% of cases)
4. Infections (encephalitis, tuberculosis, etc.)
5. Trauma (17% of cases) or neurosurgery (9% of cases)
6. Non-infectious granuloma (sarcoidosis)

the disorder is treated with vasopressin analogs such as desmopressin.

1. Nephrogenic diabetes insipidus is caused by an improper response of the kidney to antidiuretic hormone, leading to a decrease in the ability of the kidney to concentrate the urine by removing free water.

Causes includes

1. Acquired like lithium toxicity, hypercalciemea, hypokalemia, post-obstructive polyuria, sickle cell disease , amyloidosis, renal cystic disease .
2. Heridetory

Diagnosis include poly urea and hypernatremia with no clear cause

Water deprivation test is used.

then Desmopressin can also be used; if the patient is able to concentrate urine following administration of desmopressin, then the cause of the diabetes insipidus is neurogenic diabetes insipidus; if no response occurs to desmopressin, then the cause is likely to be nephrogenic.

Treatment

Treat the underlying cause, then Thiazide diuretics are used in treatment because diabetes insipidus causes the excretion of more water than sodium (i.e., dilute urine). This condition results in a net concentrating effect on the serum (increasing its osmolarity). By using thiazide diuretics, both water along with sodium and chloride is excreted, thus maintaining the blood osmolarity constant (even if blood volume is reduced). As a result, excessive polydipsia and accompanying polyuria is prevented.

**Hypokalemia**

Hypokalemia is a low level of potassium (K+) in the blood serum. Mild low potassium does not typically cause symptoms. Symptoms may include feeling tired, leg cramps, weakness, and constipation. Low potassium also increases the risk of an abnormal heart rhythm, which is often too slow and can cause cardiac arrest.

Causes of hypokalemia include vomiting, diarrhea, medications like furosemide and steroids, dialysis, diabetes insipidus, hyperaldosteronism, hypomagnesemia, and not enough intake in the diet. Normal potassium levels are between 3.5 and 5.0 mmol/L (3.5 and 5.0 mEq/L) with levels below 3.5 mmol/L defined as hypokalemia.It is classified as severe when levels are less than 2.5 mmol/L. Low levels may also be suspected based on an electrocardiogram (ECG).

The speed at which potassium should be replaced depends on whether or not there are symptoms or abnormalities on an electrocardiogram.[1] Potassium levels that are only slightly below the normal range can be managed with changes in the diet. Lower levels of potassium require replacement with supplements either taken by mouth or given intravenously. If given intravenously, potassium is generally replaced at rates of less than 20 mmol/hour. Solutions containing high concentrations of potassium (>40 mmol/L) should generally be given using a central venous catheter. Magnesium replacement may also be required

**Hyperkalemia**

is an elevated level of potassium (K+) in the blood. Normal potassium levels are between 3.5 and 5.0 mmol/L (3.5 and 5.0 mEq/L) with levels above 5.5 mmol/L defined as hyperkalemia. Typically hyperkalemia does not cause symptoms. Occasionally when severe it can cause palpitations, muscle pain, muscle weakness, or numbness.Hyperkalemia can cause an abnormal heart rhythm which can result in cardiac arrest and death.

Common causes of hyperkalemia include kidney failure, hypoaldosteronism, and rhabdomyolysis. A number of medications can also cause high blood potassium including spironolactone, NSAIDs, and angiotensin converting enzyme inhibitors. The severity is divided into mild (5.5–5.9 mmol/L), moderate (6.0–6.4 mmol/L), and severe (>6.5 mmol/L). High levels can be detected on an electrocardiogram (ECG)

Initial treatment in those with ECG changes is salts, such as calcium gluconate or calcium chloride. Other medications used to rapidly reduce blood potassium levels include insulin with dextrose, salbutamol, and sodium bicarbonate, Hemodialysis is the most effective method.

Hypocalcemia is low calcium levels in the blood serum. The normal range is 2.1–2.6 mmol/L (8.8–10.7 mg/dl, 4.3–5.2 mEq/L) with levels less than 2.1 mmol/l defined as hypocalcemia. Mildly low levels that develop slowly often have no symptoms. Otherwise symptoms may include numbness, muscle spasms, seizures, confusion, or cardiac arrest,

Common causes include hypoparathyroidism and vitamin D deficiency. Others causes include kidney failure, pancreatitis,

Initial treatment for severe disease is with intravenous calcium chloride and possibly magnesium sulfate. Other treatments may include vitamin D, magnesium, and calcium supplements.

Hypercalcemia, also spelled hypercalcaemia, is a high calcium (Ca2+) level in the blood serum. The normal range is 2.1–2.6 mmol/L (8.8–10.7 mg/dL, 4.3–5.2 mEq/L), with levels greater than 2.6 mmol/L defined as hypercalcemia. Those with a mild increase that has developed slowly typically have no symptoms. In those with greater levels or rapid onset, symptoms may include abdominal pain, bone pain, confusion, depression, weakness, kidney stones or an abnormal heart rhythm including cardiac arrest, Most cases are due to primary hyperparathyroidism or cancer

Treatment may include intravenous fluids, furosemide, calcitonin or pamidronate in addition to treating the underlying cause

**Magnesium deficiency**

is an electrolyte disturbance in which there is a low level of magnesium in the body. It can result in multiple symptoms. Symptoms include tremor, poor coordination, muscle spasms, loss of appetite, personality changes, and nystagmus. Complications may include seizures or cardiac arrest such as from torsade de pointes. **Those with low magnesium often have low potassium.**

Causes include low dietary intake, alcoholism, diarrhea, increased urinary loss, . A number of medications may also cause low magnesium, including furosemide. The diagnosis is typically based on finding low blood magnesium levels (hypomagnesemia). Normal magnesium levels are between 0.6 and 1.1 mmol/L (1.46–2.68 mg/dL) with levels less than 0.6 mmol/L (1.46 mg/dL) defining hypomagnesemia.

Treatment is with magnesium either by mouth or intravenously. For those with severe symptoms, intravenous magnesium sulfate may be used. Associated low potassium or low calcium should also be treated. The condition is relatively common among people in hospitals.