CHAPTER 7: NUTRIENTS INVOLVED IN FLUID AND ELECTROLYTE BALANCE

Fluids are substances composed of freely moving molecules that have the ability to conform to the shape of their container. There are different types of fluids in our bodies. Approximately 50 - 70% of a healthy adult’s body is composed of fluids. About 2/3 of this fluid is within body cells and is called intracellular fluid. The remaining 1/3 is extracellular (interstitial) fluid. Extracellular fluid includes: (1) tissue fluid (found between the cells within tissues and organs of the body) and (2) plasma (the fluid portion of blood that carries the blood cells).

The body fluid composition of tissue varies by (1) tissue type - lean tissues have higher fluid content than fat tissues, (2) gender - males have more lean tissue and therefore more body fluid and (3) age - lean tissue is lost with age and body fluid is lost with it.

Ions are atoms with an electrical charge. Anions are negatively charged ions and cations are positively charged. Body fluid is composed of water and electrolytes. Electrolytes are mineral salts dissolved in water. They include sodium, potassium, chloride and phosphorus. Electrolytes are ions and carry electrical charges (Ex: sodium = Na⁺, and chloride = Cl⁻). Fluids have an overall neutral charge due to the balances between electrolytes. Fluids dissolve and transport substances. Water is an excellent solvent because it can dissolve many different substances. The dissolved materials (solutions) include ions, sugars, amino acids, vitamins and minerals.


Any water lost from the body must be replaced. Water is lost through urine, sweat, exhalation and feces. Water is gained through beverages, food and metabolic reactions. Most water is lost through urine. The kidneys control how much water is reabsorbed. Excess water is processed by the kidneys and excreted as urine. Water is lost through the skin as perspiration (sensible or insensible), or through the lungs during exhalation.

Water consumption is regulated by the hypothalamus of the CNS. This is the same part of the brain that contains the "appetite" and the "thermostat". Hormones produced by the pituitary gland (ADH or vasopressin), kidney (angiotensin) and adrenal glands (aldosterone) help maintain water homeostasis.

Most water enters the body through consumption of beverages. Some foods have very high water content. Metabolic water is a product of many chemical reactions in the body and contributes 10-14% of the body’s needs. Recommended intake of water is 1.0 to 1.5 ml for each kcal expended. Intake needs vary with environment, activity level. If you drink too much water, dilution of sodium can result. Becoming over hydrated is rare, however. If you don't drink enough water, you will become dehydrated. Infants and the elderly are especially vulnerable to dehydration.

Electrolytes attract water molecules because water molecules are polar. The overall number of positive and negative charges must balance, but the exact structure of the charged material is not necessarily relevant. For example, sodium (Na⁺) and potassium (K⁺) are both positive, so if one leaves the cell and the other enters there is no problem - balance is maintained. Transport and receptor proteins on the cell membrane surface help regulate which ions can leave and which can enter. Movement of substances in and out of cell can be passive or active. Water balance must also be maintained to ensure that no part of the body will experience a shift in its natural pH. Buffers are usually at least partially made of protein and they can help resist a change in pH.
Cellular environments vary from time to time. Isotonic, hypertonic and hypotonic environments exist at different times. Cells use various transportation methods to acquire and release materials via fluids. Passive transport is movement down a concentration gradient. Osmosis, diffusion and facilitated diffusion are examples of passive transport. Active transport involves energy and material expenditures on the part of the cell. Endocytosis (either phagocytosis or pinocytosis) and exocytosis are examples of active transport.

Water is a natural resource. It is cleansed through a naturally occurring process called the water cycle, which consists of three phases: (1) evaporation, (2) condensation and (3) precipitation. Sources of water include surface and ground water. Possible sources of water contamination include heavy metals, pathogens and organic compounds. Other mechanisms for cleansing water include filtration and the addition of chemicals, such as chlorine. Water quality varies from place to place. Water supplies can be classified as either "hard" or "soft". Potable means good enough to drink. Many people purchase home filtration systems or bottled water. Unless home filtration systems are properly monitored, clean water is not a certainty. Not all bottled water is actually clean, good-quality water either!

Minerals working as electrolytes include:

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<thead>
<tr>
<th>NAME OF MAJOR MINERAL</th>
<th>SODIUM</th>
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<tbody>
<tr>
<td>FUNCTION(S)</td>
<td>Electrolyte. It helps maintain normal fluid and acid/base balance. Associated with blood pressure and pH balance in the body. Required for nerve impulse transmission. Assists in the transport of certain nutrients (e.g., glucose) into body cells.</td>
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<tr>
<td>RDI</td>
<td>500 mg/day is required; less than 2,400 mg/day is recommended</td>
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<tr>
<td>PRIMARY SOURCES</td>
<td>Table salt and soy sauce. Large amounts are present in processed foods.</td>
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<tr>
<td>DEFICIENCIES</td>
<td>Muscle cramps, apathy, dizziness, nausea and loss of appetite.</td>
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<tr>
<td>TOXICITY</td>
<td>Edema and acute hypertension.</td>
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<tr>
<th>NAME OF MAJOR MINERAL</th>
<th>POTASSIUM</th>
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<tr>
<td>FUNCTION(S)</td>
<td>Electrolyte. Fluid and electrolyte balance. Very important in muscle contractions and transmission of nerve impulses. High potassium intake helps to maintain a lower blood pressure. Danger: Can be lost from your system when using diuretics.</td>
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<tr>
<td>RDI</td>
<td>2,000 to 4,000 mg/day.</td>
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<td>PRIMARY SOURCES</td>
<td>Whole foods: meats, milk, fruits, vegetables, grains and legumes.</td>
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<tr>
<td>DEFICIENCIES</td>
<td>Muscle weakness, confusion and paralysis.</td>
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<tr>
<td>TOXICITY</td>
<td>Muscle weakness and vomiting. Not toxic when consumed as food. The use of potassium salts can be dangerous.</td>
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</table>
**NAME OF MAJOR MINERAL** | **CHLORIDE**  
---|---  
**FUNCTION(S)** | Part of stomach acid. It is an electrolyte and often works with sodium. Assists with maintaining fluid balance. Assists the immune system.  
**RDI** | Minimum recommendation is 750 mg/day.  
**PRIMARY SOURCES** | Table salt and soy sauce. Large amounts are present in processed foods.  
**DEFICIENCIES** | Dangerous pH shifts; heartbeat irregularities. This is rare but can occur in people with eating disorders.  
**TOXICITY** | Vomiting. May lead to hypertension in salt-sensitive patients.  

**NAME OF MAJOR MINERAL** | **PHOSPHORUS**  
---|---  
**FUNCTION(S)** | Bone and tooth structure. In nucleic acids and also in buffer systems. This is the major intracellular negatively charged electrolyte. Required for fluid balance. Critical role in bone formation. Regulates biochemical pathways by activating or deactivating enzymes. Found in ATP, DNA and RNA.  
**RDI** | RDA for phosphorus is 700 mg/day.  
**PRIMARY SOURCES** | Animal tissues: meat, fish, poultry, eggs and milk.  
**DEFICIENCIES** | Weakness and bone pain. Deficiencies of phosphorus are rare.  
**TOXICITY** | Low blood calcium levels, convulsions and muscle spasms. High blood phosphors can occur with kidney disease or when taking too many vitamin D supplements. Causes muscle spasms, convulsions.  

Review these diseases that relate to fluid-electrolyte imbalance:  
Dehydration  
Heat stroke  
Hyperhydration  
Hyperkalemia  
Hypernatremia  
Hypokalemia  
Hyponatremia  
Muscle disorders  
Neuropsychiatric disorders