

Fluid and electrolytes essay sample



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* Extracellular Fluid (ECF) - This is fluid found outside of the cells and the amount of ECF decreases with age. In the newborn for example, approximately $\frac{1}{2}$ of the body fluid is contained in the ECF. By the time the infant has reached one year old; the ECF has decreased to approximately $\frac{1}{3}$ of the total volume. In an average 70 kg adult the ECF is approximately 15 liters of total volume. ECF can further be divided into the following: *

Interstitial Fluid - This is the fluid that surrounds the cells and equals approximately 11 to 12 liters of fluid in adults (Lymph fluid is included in interstitial fluid). * Intravascular Fluid - This is the fluid contained within the blood vessels (plasma volume). The average adult blood volume is approximately 5 to 6 liters or which approximately 3 liters is plasma. The remaining 2 or 3 liters of volume consists of red blood cells and erythrocytes (which transport oxygen and important body buffers). * Transcellular Fluid - This is fluid contained within specialized cavities of the body and is also considered to be part of the ECF. Examples of transcellular fluid include: *

Cerebral Spinal Fluid

* Pericardial Fluid

* Pleural Fluid

* Synovial Fluid

* Intraocular Fluid

* Digestive Secretions

Intracellular Fluid (ICF) - This is the fluid that is contained within the cell. In adults it is approximately $\frac{2}{3}$'s of the body's fluid (27 liters). The ICF also known as "cellular soup" is comprised mostly of potassium, organic anions, proteins and other small cations and anions. Note: The 60-40-20 rule is that

in total 60% of our body weight is water with 40% of that being intracellular with the remaining 20% being extracellular.

Factors That Affect Movement of Water and Solutes:

Membranes - Each of the fluid compartments are separated by specific permeable membranes that allow the movement of water and some solutes (not plasma proteins for example because they are large molecules).

Because permeability is selective; the composition of each compartment (ECF, ICF) maintains its own unique composition. Specific semi-permeable membranes include: * Cell Membranes - these membranes separate intracellular fluid from interstitial fluid, and are composed of lipids and proteins. * Capillary Membranes - these membranes separate intravascular fluid from interstitial fluid. * Epithelial Membranes - these membranes separate interstitial fluid and intravascular fluid from transcellular fluid. The

Transport Process:

In addition to the use of membranes (permeable and semi-permeable); the movement of water and solutes are determined by the following processes:

Diffusion - This is the random movement of particles in all directions from an area of high concentration to low concentration. One example of diffusion is the movement of oxygen from the alveoli of the lungs into the blood stream. Another example of diffusions occurs when cations follow anions and vice versa. Substances may diffuse across the cell wall (which is composed of lipids and proteins) under the following conditions: * The substance is small enough to pass through the protein pores (water, urea). * The substance is lipid soluble (oxygen and carbon dioxide). * The substance is transported by a " carrier substance" (Fore example, because glucose is such a large

molecule it must combine on the outside of the cell with a carrier substance to be moved into the cell). Factors that increase diffusion include:

- * Increased temperature
- * Increased concentration of solutes
- * Decreased size or weight of solutes
- * Increased surface area available for diffusion
- * Decreased distance across which the solute mass must diffuse

Active Transport - The need for active transport (energy) is also a requirement for simple diffusion. Active transport also relies on the availability of carrier substances. Important solutes that require active transport to move in and out of the cells are:

- * Sodium
- * Potassium
- * Hydrogen
- * Glucose
- * Amino-Acids

Filtration - This is the movement of water and solutes from an area of high hydrostatic pressure to an area of low hydrostatic pressure. Hydrostatic pressure is the pressure that is created by the "weight" of fluid. It is filtration for example, that allows the kidneys to filter plasma (approximately 180 liters per day).

Osmosis - This is the movement of water across a semi-permeable membrane from an area of lower solute concentration to an area of higher solute concentration. Osmosis can occur on either side of the membrane

when changes in concentration occur. The following are terms that are associated with osmosis: * Osmotic Pressure (the amount of hydrostatic pressure required to stop the osmotic flow of water) * Oncotic Pressure (the osmotic pressure exerted by colloids which are proteins such as albumin) * Osmotic Diuresis (increased urine output caused by substances such as Mannitol, glucose or contrast medium) * Osmolality (the ratio of solutes to water)

Regulation of Vascular Volume:

In an attempt to maximize the environment for the body's cells, the extracellular fluid volume (ECF) is continually being regulated by a combination of renal, metabolic and neurological functions. Though "the total content of sodium" in the ECF determines the ECF volume, there are other regulatory properties that alter and modify the ECF as the body changes. The following are examples of the body's fluid volume regulatory systems:

The Sympathetic Nervous System (SNS) - The SNS provides the initial compensatory response to rapid and short term changes in the ECF. Changes in stretch that are sensed by volume receptors for example lead to changes in sympathetic tone (i. e. cardiac output, arterial resistance and release of renin by the kidneys).

Renin-Angiotensin - Renin is released from the kidneys in response to decreased renal perfusion. Here is the process: * Renin acts on Angiotensin to produce Angiotensin 1

* Angiotensin 1 is converted by an enzyme to Angiotensin 2 which is a potent

vasoconstrictor * Angiotensin 2 stimulates the release of Aldosterone

* Aldosterone is a mineralcorticoid hormone released by the adrenal cortex and acts to increase reabsorption of sodium * The reabsorption of sodium leads to water retention making Aldosterone a potent and important volume regulator Natriuretic Peptides - These peptides are hormones that influence fluid volume and cardiovascular function through increased excretion of sodium, direct vasodilation and opposing the Renin-Angiotensin process. The following three natriuretic peptides have been identified: * Type A - produced by the atrial myocardium

* Type B - produced by the ventricular myocardium

* Type C - produced by the vascular endothelium

Note: Type A and B peptides are released in response to increased pressure in the myocardium while Type C peptide is released in response to vascular bed changes.

Antidiuretic Hormone (ADH) - Produced by the hypothalamus and secreted by the posterior pituitary gland; ADH acts on the collecting ducts of the kidney to increase the reabsorption of water and allow for the excretion of concentrated urine. ADH is primarily regulated by plasma osmolality and ECF volume. Factors that increase the release of ADH include: * Increased plasma osmolality

* Decreased extracellular fluid volume

* Decreased blood pressure

* Stress and pain

* Medications such as Morphine and Barbiturates

- * Surgery and certain anesthetics
- * Positive pressure ventilation

Factors that decrease the release of ADH include:

- * Decreased plasma osmolality
- * Increased extracellular fluid volume
- * Increased blood pressure
- * Certain medications such as Dilantin

Medications that alter the action of ADH include:

- * Lithium (suppresses)
- * Demeclocycline (suppresses)
- * Methoxyflurane (suppresses)
- * Chlorpropamide (enhances)
- * Indomethacin (enhances)

Note: In addition to ADH, thirst also acts to regulate extracellular fluid concentrations and is essentially stimulated by the same factors that stimulate ADH.

Reference: http://dynamicnursingeducation.com/class.php?class_id=88πd=17

The distribution of body fluids

The main fluid in the body is water. Total body water is 60% of body weight.

The water is distributed in three main compartments separated from each other by cell membranes. The intracellular compartment is the area within the cell. The extracellular compartment consists of the interstitial area

(between and around cells) and the inside of the blood vessels (plasma).

Compartments of

Body and Distribution of Water by Weight

Plasma 5%

Interstitial 15%

Intracellular 40%

Total 60 % Water

Solids - 40%

fat, protein, carbohydrates,

minerals

Electrolytes are the chemicals dissolved in the body fluid. The distribution has important consequences for the ultimate balance of fluids. Sodium chloride is found mostly in extracellular fluid, while potassium and phosphate are the main ions in the intracellular fluid. Electrolytes are ions that form when salts dissolve in water or fluids. These ions have an electric charge. Positively charged ions are called cations. Negatively charged ions are called anions. Electrolytes are not evenly distributed within the body, and their uneven distribution allows many important metabolic reactions to occur. Sodium (Na^+), Potassium (K^+), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), chloride (Cl^-), phosphate (HPO_4^{2-}), bicarbonate (HCO_3^-), and Sulfate (SO_4^{2-}) are important electrolytes in humans. Specific electrolyte imbalances

Each electrolyte has a special function in the body, although if one electrolyte is out of balance, the concentrations and actions of other electrolytes are often affected. The serum concentration of sodium,

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potassium, and chloride can be measured in a simple blood test. Sodium, chloride, potassium, and calcium concentrations can also be determined from a urine sample. A urine test helps show how well the kidneys are functioning. Electrolyte imbalances are most common among the seriously ill and the elderly. Kidney (renal) failure is the most common cause of electrolyte imbalances SODIUM. Sodium affects how much urine the kidney produces and is involved in the transmission of nerve impulses and muscle contraction. Too high a concentration of sodium in the blood causes a condition called hypernatremia. Causes of hypernatremia include excessive water loss (e. g., severe diarrhea), restricted water intake, untreated diabetes (causes water loss), kidney disease, hormonal imbalances, and excessive salt (NaCl) intake.

Symptoms include signs of dehydration such as extreme thirst, dark urine, sunken eyes, fatigue, irregular heart beat, muscle twitching, seizures, and coma Too low a concentration of sodium in the blood causes hyponatremia. This is one of the most common electrolyte imbalances, and occurs in about 1% of hospitalized individuals. It can result from vomiting, diarrhea, severe burns, taking certain drugs that cause the kidneys to selectively excrete sodium, inadequate salt intake, water intoxication (a problem among the elderly with dementia), hormonal imbalances, kidney failure, and liver damage. Symptoms include nausea, vomiting, headache, tissue swelling (edema), confusion, mental disorientation, hallucinations, muscle trembling, seizures, and coma POTASSIUM. Potassium ions play a major role in regulating fluid balance in cells, the transmission of nerve impulses, and in

muscle contractions. Too high a concentration of potassium causes a condition called hyperkalemia that is potentially life threatening.

The most common cause is kidney failure. It can also result from severe burns or injury (excess potassium released from injured cells), inadequate adrenal hormones (Addison's disease), the use of certain medications, and excessive use of potassium supplements. Sometimes hyperkalemia occurs in conjunctions with hypernatremia. Symptoms include nausea, diarrhea, weakness, muscle pain, and irregular heart beat, coma and death

Abnormally low concentrations of potassium cause hypokalemia.

Hypokalemia can result from excess adrenal hormones (Cushing's disease), kidney disease, long-term use of certain diuretic drugs, laxative abuse, bulimia, and kidney failure. Symptoms include increased production of urine, muscle pain, paralysis, irregular heart beat, and low blood pressure

CALCIUM. Calcium is needed to build and maintain bones. It also plays a role in nerve impulse transmission and muscle contraction. Excess calcium results in a condition called hypercalcemia. Hypercalcemia can be caused by too much parathyroid hormone (PTH), certain cancers, some genetic disorders, and excessive use of antacids containing calcium in rare cases.

Symptoms include bone and muscle pain, mental changes such as depression and confusion, increased urine production, fatigue, nausea, and vomiting Abnormally low concentrations of calcium cause hypocalcemia.

Hypocalcemia can be caused by too little parathyroid hormone, kidney failure, and vitamin D deficiency. Vitamin D is necessary for the body to absorb calcium. Symptoms include muscle twitches and spasms, convulsions, mental changes such as depression and irritability, dry skin, and

brittle nails -MAGNESIUM. Magnesium is involved in protein synthesis and cellular metabolism. Abnormally high concentrations of magnesium, or hypermagnesemia, may occur with severe (end-stage) renal failure or by overdose of magnesium-containing intravenous fluids. Hypermagnesemia is rare. Symptoms include exhaustion, low blood pressure, depressed heart and breathing rate, and slow reflexes Abnormally low concentrations of magnesium, or hypomagnesemia, are most common among people with alcoholism and those who are severely malnourished. Other causes include digestive disorders that interfere with the absorption of magnesium from the intestines.

Symptoms of hypomagnesemia include vomiting, weight lose, leg cramps, muscle spasms, seizures, and irregular heartbeat CHLORIDE. Chloride is involved in regulating blood pressure. High concentrations of chloride, called hyperchloremia, can be caused by kidney failure, kidney dialysis, and an overproduction of parathyroid hormone. Symptoms include weakness, headache, nausea, and vomiting. In people with diabetes, hyperchloremia makes it difficult to control blood glucose levels Hypochloremia often occurs along with hypona-tremia or hypokalemia and is caused by excessive fluid loss (e. g., diarrhea). Serious deficiencies of chloride cause the blood to become less acidic, resulting in a condition called metabolic alkalosis. Symptoms of severe hypochloremia include confusion, paralysis, and difficulty breathing PHOSPHATE. Phosphate helps control the acidity level (pH) of the blood.

Phosphate also causes calcium to be deposited in bones. High blood levels of phosphate, or hyperphosphatemia, often result in too low levels of calcium,

or hypocalcemia. Hyperphosphatemia is usually caused by kidney failure. It can also result from kidney dialysis, parathyroid gland dysfunction, and several inherited diseases. Mild hyperphosphatemia usually produces no symptoms. Severe imbalance can cause tingling in the fingers, muscle cramps, and convulsions Hypophosphatemia, or abnormally low concentrations of phosphate in the blood, often occurs along with hypomagnesemia and hypokalemia. It can also be caused by kidney disease, kidney dialysis, vitamin D deficiency, and hormonal imbalances. Up to 30% of individuals admitted to hospital intensive care units have hypophosphatemia.