Title	Why We Hang What We Hang
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Course No	WWH090607
Contact Hour	1

Purpose

Many of our patients in the hospital have some type of intravenous therapy as part of their care. As a nurse, it is our responsibility to be familiar with how these fluids affect our body as well as the make-up of the different IV solutions. In this article, we will discuss the pathophysiology of fluids and electrolytes and examine why the different IV solutions are used in various medical conditions.

Objectives

1. List the composition of the main fluid compartments of the body
2. Define osmolality
3. Describe how body fluids move and are regulated in the body
4. Discuss what role electrolytes play in the body's fluid and chemical balance
5. Distinguish between colloid and crystalloid solutions
6. Name nursing considerations for patients on IV therapy

What we are made of

Composition of ICF and ECF

The body's two major fluid compartments are the Intracellular Fluid (ICF) and Extracellular Fluid (ECF). The major electrolytes of the ICF are potassium and phosphorous. The major electrolytes of the ECF include sodium and chloride. ECF can be further broken down into interstitial fluid (ISF) and intravascular fluid (plasma). (2) The ISF surrounds the cells of the body and the plasma is the liquid portion of blood that makes up most of the blood volume. The reason that certain electrolytes stay inside the cell and other electrolytes stay outside the cell is because there is a selective permeable membrane between the two compartments. This membrane is "selective" in what it allows to come out and go in to maintain balance inside and outside the cell.

Osmo-What?

The Merriam-Webster Medical Dictionary defines osmolality as "the concentration of an osmotic solution, especially when measured in osmols or milliosmoles per 1000 grams of solvent." (3) Sometimes the word osmolarity is used instead of osmolality. The difference between osmolality and osmolarity is based on the osmotic concentration. Osmolality is measured in milliomoles/kg (mOsm/kg) where osmolarity is expressed in milliosmoles/liter (mOsm/L). Basically, what this means is osmolality is the way our bodies seek a balance of our own body fluids. It is the concentration of a fluid and can be measured by a lab test. Normal serum osmolarity is around 300 mOsm/L. A decrease in serum osmo means a decrease in concentration of solutes, therefore a more dilute environment. This is indicative of fluid overload. An increase in serum osmo means an increase in the concentration of solutes and a more concentrated environment. This shows hemoconcentration and dehydration.

I Like the Way You Move: Mechanisms by Which Body Fluids Move and are Regulated

The fluids in our body are in constant movement. The different electrolytes, waste products and nutrients can move in and out of cells. Which substances can go where is determined by the compartments membrane permeability and osmotic pressure (aka hydrostatic pressure). Balance is maintained because solutes can move from one compartment to another when there is a deficiency or abundance of a particular molecule.

Fluids and solutes have several different ways of moving in and out of cells. To maintain homeostasis, fluids move between compartments by a process called osmosis. Osmosis is the diffusion of a fluid, particularity water, across a semi-permeable membrane from an area of higher concentration to an area of lower concentration. Most solutes, like electrolytes, move between compartments by diffusion. Diffusion is the spontaneous movement of particles from an area of high concentration to an area of low concentration. (4) Solutes can also move between compartments by active transport. This is how electrolytes can move from an area of lower concentration to an area of higher concentration. One example of active transport is the sodium-potassium pump. (2) This pump controls sodium out of the cells with the movement of potassium into the cells. These processes help keep the concentration of fluid and solutes equal between the ICF and ECF and maintain homeostasis.

What electrolytes have to do with it

Electrolytes play a major role in the body's ability to maintain a chemical balance. These electrolytes include sodium, potassium, calcium, chloride, phosphorus and magnesium. As mentioned before, sodium and potassium are the major ions in the ICF and ECF and help control the amount of fluid and solutes that shifts between the compartments. Calcium helps to maintain the cell-membrane structure, function and permeability. Chloride is also found in the ECF and helps to maintain serum osmolarity (along with sodium). Phosphorus is a major ion found in the ICF and helps to maintain the cell integrity. Finally, magnesium is found in the ICF and facilitates sodium and potassium movement across all membranes. (2)

It's in the bag

Colloids and blood products

Colloid solutions increase the intravascular volume by drawing fluid from the interstitial and intracellular spaces. Colloids mimic a hypertonic solution except that colloids contain larger molecules, such as proteins, sugars and starches that cannot pass through the capillary membrane. Because of the larger molecules, colloids linger in the intravascular system. Common colloid solutions include albumin and blood products. Human albumin is a small plasma protein separated from plasma. It comes in a 5% (buffered saline) and 25% (salt-poor) solution. It is given to replace volume and to treat hypoproteinemia. (1,2) Since cross-typing isn't necessary for albumin, it is routinely given as a volume expander until a type and cross-match can be done. Blood products such as whole blood and packed red blood cells (PRBCs) are also used to restore blood volume if a patient has been hemorrhaging. Fresh frozen plasma, which contains plasma proteins, albumin and clotting factors, is another blood product that is useful when a patient needs clotting factors. Most colloids are just as useful as crystalloids in pumping up volume, however, due to increased cost, crystalloids are more commonly used for this purpose. (1) Indications for colloid use include restoring blood volume, restoring or maintaining oxygen carrying capacity, to correct anemia and to increase red blood cell mass. (2) Colloids are often the solution of choice to patients with third-spacing (fluid accumulation in areas that normally have no or a minimal amount of fluid) because they draw fluid from the interstitial space.

Crystalloids are solutions that are formulated to approximate the mineral content of human plasma. (1) Remember that plasma is part of the ECF. These fluids are used to expand circulating volume and replace intravascular fluid. Crystalloids come in three different tonicities (another term for osmolarity). Solutions are categorized based on their tonicity relative to normal blood plasma. The three classes of crystalloids are isotonic, hypertonic and hypotonic.

The pre-fix "iso" means equal. In this case, the isotonic solution is "equal" to the other fluids, such as serum, in our body. In other words, isotonic solutions have the same osmolarity (tonicity) as serum, around 300 mOsm/liter. (2) Fluid does not move into or out of cells because the osmotic pressure on both sides of the membrane is the same and osmosis does not occur. An isotonic solution will stay where it was infused, in the intravascular system. Examples of isotonic solutions include 0.9% normal saline (NS), Lactated ringers (LR) and dextrose 5% in water (D5W). Although D5W is an isotonic solution when it enters the body, it acts like a hypotonic solution because the dextrose molecules are quickly broken down and used by the body as energy. LR is the closest fluid that mimics human plasma because it contains several of the same electrolytes. Examples of patients that may receive an isotonic solution include blood loss from trauma or surgery and patients with dehydration.

Hypertonic solutions have a solute concentration higher than serum. The osmolarity is greater than 300 mOsm/liter. (1) Because solutes moves from an area of lower concentration to an area of higher concentration, infusing a hypertonic solution causes fluid to move from the cells into the extracellular compartment (where the solution is infused) and causes the cells to shrink. These solutions are used in postoperative patients to reduce the risk of edema, stabilize blood pressure and regulate urinary output. Some common hypertonic solutions include mannitol, dextrose 5% 0.45% normal saline (D5 ½ NS) and dextrose 5% normal saline (D5NS). (1,2) For instance, a patient with cerebral edema can benefit from mannitol because of its osmotic properties. Hypertonic solutions, like mannitol, promote the movement of fluid from the intracellular to the extracellular space.

A hypotonic solution hydrates cells while reducing the fluid in the circulatory system. Hypotonic solutions may be given to patients that have conditions that cause cellular dehydration to "plump up" the cells. Patients that have received too much diuretic therapy, for example, may benefit from a hypotonic solution. These solutions also will help hyperglycemic conditions, such as diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic nonketotic syndrome (HHNS) because glucose will move back into the cell in a hypotonic atmosphere. Since DKA patients are at risk for electrolyte imbalances, dehydration and vascular collapse due to acidosis, they should initially be given an isotonic solution such as NS. Because the fluid and solutes are moved from the intravascular system into the cells, complications from the therapy may be hypotension, increased intracranial edema and dehydration. (1,2) Some commonly used hypotonic solutions include 0.45% normal saline (1/2 NS) and dextrose 2.5 in water. Remember, D5W is an isotonic solution but becomes hypotonic upon entering the bloodstream. A useful way to help you remember that 0.45% NS is a hypotonic solution is to say, "half normal hydrates the cell".

What's a nurse to do? Nursing considerations for patient on IV therapy

IV therapy can affect a patient's fluid volume status and may cause complications. Monitoring for these complications should be a top priority of the nursing assessment. Because many of the solutions increase intravascular volume, the patient should be monitored for volume overload. Signs and symptoms of fluid volume overload include neck vein distention, respiratory distress, increased blood pressure, and adventitious lung sounds. (1,2) Intake and output, daily weights and vital signs should be routinely checked. If volume overload is suspected, the solution should be discontinued and oxygen and diuretics administered, if necessary, as ordered by the physician. If a patient is receiving solutions with electrolytes, such as Lactated Ringers, be sure to monitor their lab values for any increase in those electrolytes. Electrolyte imbalances such as hyperkalemia may cause cardiac arrhythmias. Patients receiving blood products should be monitored for allergic reactions and should have vital signs taken more frequently early in the transfusion. Be sure to follow your institution policy and procedure on administering blood products.

Complications such as infiltration, extravasation and phlebitis may also occur in IV therapy patients. (2) Infiltration occurs when the IV solution being infused leaks into the surrounding tissue. This may be due to the improper placement of the catheter or the IV becomes dislodged due to patient movement. Most of the time infiltration of a non-irritating fluid does not cause any damage to the patient, unless there is a large amount of fluid that has accumulated in the tissues. If an irritating medication, such as some antibiotics, potassium and amphotericin B, leaks into the surrounding tissue, this is termed extravasation. This is a more serious complication and can cause discomfort, infection and/or necrosis. Phlebitis is the inflammation of the vein from either irritating drugs and solutions, using a catheter in a vein that is too small or prolonged use of the IV site. The vein will appear swollen and red and will be tender to the touch. If phlebitis has occurred, be sure to move the IV to another site and apply warm compresses to the affected area.

By being informed of the different types of IV solutions and possible complications, you will be assured that you are giving the best possible care to those patients receiving IV therapy.

References

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3. Merriam Webster Medical Dictionary. http://www.intelihealth.com/IH/ihtIH/WSIHW000/9276/9276.html (22 Aug 2006).
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Course Exam

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1. The two main fluid compartments in the body are the Intracellular and Extracellular fluid compartments.

   ○ True ○ False

2. The term osmolality refers to the concentration of an osmotic solution.

   ○ True ○ False

3. Osmosis is the diffusion of a fluid across a non-permeable membrane.

○ True ○ False

4. Sodium and calcium are the two major ions in the ICF and ECF.

   ○ True ○ False

5. Colloid solutions increase the intravascular volume by drawing fluid from the interstitial and intracellular spaces.

   ○ True ○ False

6. Common colloid solutions include albumin and blood products.

   ○ True ○ False

7. An example of an isotonic solution is D5NS.

   ○ True ○ False

8. A hypotonic solution hydrates cells while reducing the fluid in the circulatory system.

   ○ True ○ False

9. Signs and symptoms of fluid volume overload include neck vein distention, respiratory distress and increased blood pressure.

   ○ True ○ False

10. If a patient has phlebitis from an IV, the nurse should NOT move the catheter to another site.

    ○ True ○ False