BODY FLUIDS

ALL BODY FLUIDS CONTAIN THE SOLVENT WATER (H₂O) AND IT'S VARIOUS SOLUTES AMOUNTS

HUMANS ARE 60-80 % FLUID BY WEIGHT
%AGE VARIES WITH:
< AGE (9AGE, 8%)
< SEX (& HAVE 9)
< BODY FAT CONTENT (8 FAT, 9 BODY H₂O)
THE YOUNGER THE PERSON, THE HIGHER THE %AGE OF BODY WATER
WOMEN HAVE « BODY WATER THAN MEN BECAUSE MOST WOMEN HAVE A HIGHER
BODY FAT CONTENT
A FAT PERSON CONTAINS LESS BODY WATER THAN A THIN ONE AS FAT HAS VERY LITTLE WATER CONTENT

MAJOR COMPARTMENTS

INTRACELLULAR OR CELLULAR
X THE FLUID WITHIN THE CELL
X COMPRISSES 3/4 OF TOTAL BODY WATER
EXTRACELLULAR
X ALL OF THE FLUID OUTSIDE THE CELL WALLS
X INTRAVASCULAR OR PLASMA — THE FLUID CONTENT OF BLOOD
X INTERSTITIAL — THE FLUID IN WHICH THE TISSUE CELLS ARE BATHED

%AGE VARIES

INFANTS HAVE A HIGHER %AGE OF INTERSTITIAL FLUID
X A FULL-TERM NEWBORN'S BODY WEIGHT IS APPROXIMATELY 80% WATER
X A PREMATURE INFANT'S BODY WEIGHT IS APPROXIMATELY 90% WATER
X THE %AGE 9'S WITH AGE UNTIL PUBERTY
AN ADULT (FROM PUBERTY TO 60) IS APPROXIMATELY 60% WATER BY WEIGHT
AFTER AGE 60 THE %AGE DROPS TO 45%

ADULT INFANT
ECF ≥ 15-20 % ECF ≥ 45 %
ICF ≥ 40-45 % ICF ≥ 35 %

FUNCTIONS OF BODY FLUIDS

-WATER IS THE PRINCIPLE BODY FLUID-
1. FACILITATE THE TRANSPORT OF NUTRIENTS, HORMONES, PROTEINS, AND OTHER MOLECULES INTO THE CELLS
2. AID IN THE REMOVAL OF CELLULAR METABOLIC WASTE PRODUCTS
3. PROVIDE A MEDIUM IN WHICH CELLULAR METABOLISM TAKES PLACE
4. REGULATE BODY TEMPERATURE
5. PROVIDE LUBRICATION OF MUSCULOSKELETAL JOINTS
6. ACTS AS A COMPONENT IN ALL BODY CAVITIES
7. HELPS DIGESTION AND PERISTALSIS

COMPOSITION

COMPOSED OF H₂O AND OTHER DISSOLVED SUBSTANCES CALLED ELECTROLYTES—THEY HAVE ALSO BEEN CALLED MINERALS, SALTS, OR CRYSTALLOIDS
ELECTROLYTES ARE SO NAMED BECAUSE THEY IONIZED WHEN DISSOLVED—SOME HAVE POSITIVE CHARGES AND SOME HAVE NEGATIVE CHARGES

CATIONS
ELECTROLYTES WITH [ CHARGES
SODIUM ≥ Na⁺
POTASSIUM ≥ K⁺
CALCIUM ≥ Ca⁺⁺
MAGNESIUM \( \rightarrow \) HYDROGEN \( \rightarrow \) ANIONS

ELECTROLYTES WITH A \(-\) CHARGE

CHLORIDE \( \rightarrow \) CI \(^-\)

PHOSPHORUS USUALLY AS

\( \rightarrow \) PHOSPHATE WHICH \( \rightarrow \) PO\(_4^{3-}\)

SULFATE \( \rightarrow \) SO\(_{4}^{2-}\)

BICARBONATE \( \rightarrow \) HCO\(_3^{-}\)

CARBONIC ACID \( \rightarrow \) H\(_2\)CO\(_3\)

PROTEINATE \( \rightarrow \) THE PLASMA PROTEINS SUCH AS ALBUMIN & GLOBULIN

ORGANIC ACIDS

CATIONS AND ANIONS EXIST IN EQUAL STRENGTH AND NUMBERS WHEN MEASURED ACCORDING TO THEIR CHEMICAL ACTIVITY

ICF: HAS LARGE AMTS OF K\(^+\), Mg\(^{++}\), and PO\(_4^{3-}\)

ECF: HAS MORE PROTEINATE IN THE INTRAVASCULAR COMPARTMENT THAN THE INTERSTITIAL COMPARTMENT AS IT ACTS LIKE A SPONGE TO PREVENT PLASMA FROM SEEPING INTO THE INTERSTITIAL AREA

SOURCES OF BODY WATER

- Ingested liquids
- Ingested foods
- Tube feedings
- Oxidation of foods
- Oxidation of body tissues
- Parenteral liquids

AVENUES OF NORMAL LOSS OF BODY WATER

- Kidneys
- Intestinal tract
- Insensible Loss--not measurable
  - Skin through evaporation of perspiration
  - Lungs through exhaled moisture

TYPES OF WATER LOSSES

- Vomiting
- Burn or wound exudate
- Gastric suction
- Paracentesis
- Colitis
- Stools
- Urine
- Loss into injured spaces as edema
- Third spacing- intestinal pooling
- Draining intestinal fistula

ORGANS OF HOMEOSTASIS

LUNGS

X Regulate O\(_2\) and CO\(_2\) levels in the blood
X Since CO\(_2\) comes from the carbonic acid (H\(_2\)CO\(_3\)) levels in the blood, the lungs help maintain the acid-base balance in the ECF
X Chief role of the lungs is in excreting CO\(_2\) when there is an excessive concentration of H\(^+\)
in the ECF or retaining CO₂ when there is a deficit of H⁺ in the ECF

**RENOCARDIOVASCULAR SYSTEM**

X **Kidneys**

X Called the master chemists

X How the kidneys function, not what we eat or drink, determines the volume and chemical composition of the ECF

X Excretory function—
  - excrete products of protein catabolism
  - excrete powerful acids
  - excrete certain drugs & toxins

X Regulatory function
  - regulate concentration of electrolytes and quantity of water in ECF
  - regulate BP through the secretion of renin in the juxtaglomerular apparatus of the kidney
  - regulate the regeneration of HCO₃⁻ when it is needed
  - convert one form of vitamin D which the body cannot use to a form it can use

X Manufacturing function
  - synthesizing erythropoietin necessary for normal red blood cell function

X **Heart** - Kidneys are completely dependent on the heart which pumps 1700 L of blood to the kidneys daily for cleansing

X **Adrenal gland**

X located above the kidneys

X secrete numerous hormones

X key hormone is aldosterone—great sodium saver. While conserving Na⁺, it also saves Cl⁻ and excretes K⁺

X epinephrine— from the adrenal medulla, imitates the sympathetic nervous system in times of emergency

**PITUITARY GLAND**— directly affects the body’s conservation of H₂O through secretion of ADH

X (Antidiuretic hormone)—the hormone is actually produced in the hypothalamus and then stored in the posterior pituitary

X [ ADH ] → [ urine ]

X [ ADH ] → [ urine ]

**PARATHYROID GLAND**

X regulates level of Ca²⁺ in the ECF by secretion of Parathormone

X acts to elevate serum Ca²⁺ when levels ↓

**THYROID GLAND**

X thyroxin increases blood flow

X increased blood flow increases renal circulation which results in increased glomerular filtration and urinary output

**GI TRACT**

X absorb water and nutrients

**NERVOUS SYSTEM**

X acts as a switchboard

X functions chiefly in regulation of Na⁺ and H₂O intake and excretion. Thirst center is in the hypothalamus

**ROUTES OF TRANSPORT**

Osmosis

Diffusion

Active Transport — Na⁺/K⁺ pump

Filtration

Pinocytosis

Phagocytosis
PRINCIPLE ELECTROLYTES

Sodium — Na⁺
- Chief ECF cation
- Na⁺ concentration is primarily responsible for maintaining the volume & isotonicity of body fluids
- Has major role in acid-base balance
- Moves easily between the intravascular & interstitial spaces
- Moves across cell walls by active transport
- Influences chemical reactions in nervous and muscular tissue cells
- Maintained within a relatively narrow range
- Excess is eliminated or conserved by the kidneys — conservation is influenced by aldosterone
- Average intake is the US is 2-7 GM

Potassium — K⁺
- Major ICF cation
- Na⁺ & K⁺ work reciprocally — [‘d Na⁺ intake results in [‘d K⁺ excretion
- Chief regulator of cellular enzyme activity and cellular water content
- Vital role in: (1) transmission of electrical impulses in the heart, nervous, skeletal, lung, & intestinal tissues; (2) protein & CHO metabolism; (3) cellular building
- Excreted by kidneys
- No effective method for conservation
- ADR = 2.5 Gm

Calcium — Ca²⁺
- Most abundant cation in the ECF — 99% is unavailable as it is bound in the bones and teeth
- Works with Phosphorus
- Necessary for: (1) nerve impulse transmission; (2) blood clotting; (3) muscle contraction
- Utilization is stimulated by Vitamin D
- ADR = 1 Gm for adults

Phosphorus (Phosphate) — PO₄⁻³
- Major ICF anion
- Functions: (1) helps maintain acid-base balance; (2) bones & teeth; (3) nerve & muscle action; (4) CHO metabolism; (5) cell division & transmission of inherited traits

Chloride — Cl⁻
- Chief ECF anion
- Functions: (1) essential for production of the gastric acid HCl; (2) paired with Na⁺ & excreted or conserved by the kidneys; (3) Cl⁻ deficits cause K⁺ deficits and visa versa; (4) has a role in acid-base balance

Magnesium — Mg²⁺
- ICF cation
- Functions: (1) CHO & protein metabolism; (2) helps maintain electrical activity in nerve & muscle membranes; (3) important for vital reactions related to the body’s enzymes
- Levels are controlled by the kidneys

Bicarbonate — HCO₃⁻
- An anion — both ECF & ICF but more in the ECF
- Essential for acid-base balance — bicarbonate, sodium & carbonic acid constitute the body’s primary buffer system
- Levels are regulated by the kidneys
- In the plasma (ECF) bicarbonate varies inversely with ICF potassium

Miscellaneous Electrolytes
- Sulfate — SO₄⁻² — An anion primarily in the ICF & is associated with cellular protein; excess is
excreted by the kidneys

< Organic acid anions such as lactic acid
< Proteinate anion — functions in diffusion to move substances; an example is the plasma proteins albumin and globulin

RISK FACTORS FOR FLUID, ELECTROLYTE AND ACID-BASE IMBALANCES

- Chronic diseases
  X Cancer
  X Cardiovascular disease such as right-sided heart failure (CHF)
  X Endocrine disease such as Cushing’s disease and Diabetes Mellitus
  X Malnutrition
  X Pulmonary disease such as CorPulmonale
  X Renal disease such as progressive renal failure

- Trauma
  X Crush injuries
  X Head injuries

- Burns

- Drug Therapy
  X Diuretics
  X Steroids
  X Aldactone or other aldosterone inhibiting agents

- Gastroenteritis

- Nasogastric suctioning

- Fistulas

- IV therapy

- TPN

FACTORS INFLUENCING FLUIDS AND ELECTROLYTES

- Age
  X Infants’s proportion of total body water is & that of a child or adult , but they aren’t protected from fluid loss
  X Infant’s are at & risk for dehydration
  X Regulatory responses to imbalances are stabilize in children--children respond to illness with [ fevers
  X Adolescents have [’d metabolic processes and [’d production--girls have & fluid changes because of hormonal fluctuations
  X Pregnant women have [’d aldosterone secretion and excretion @ about the 15th week. @ the end of pregnancy, the & has . 6.5 L of extra fluid (3.5 L from fetus, placenta, and amniotic fluid; and 3 L from [’s in blood volume, breast size, & uterus). Circulating blood volume [’s 40%-45% about 2-6 wks prior to delivery and [’s rapidly after delivery
  X Elderly client’s imbalances are closely linked to [’d renal function and lack of urine concentration. Balances are also altered by chronic illnesses. Total amount of body water [’s by about 8% with old age

- Body size
  X Obese clients have proportionately body water because fat contains no water
  X Because & have fat deposits than %, they have body water

- Environmental Temperature
  X Overall body response to temperatures 28E- 30E C (82.4E-86E F) is [’d water loss by sweating
Healthy adult can sweat 1 L per hour for 2 hours, losing 5% of body weight without problems. Weight loss of over 7% causes a decrease in water conservation by the body. The evaporation of sweat ceases at 60% relative humidity and ceases at 75%. Body responses to excessive environmental temperature include: peripheral vasodilation; fluid loss via sweating; loss of Na+ & Cl-; cardiac output & pulse rate; and aldosterone secretion with Na+ retention and K+ excretion.

Life-style

Inadequate nutrition causes body to preserve protein by breaking down glycogen and fat. When these are gone, the body destroys protein to cause hypoalbuminemia with decreased serum osmotic pressure and edema. Stress causes aldosterone and glucocorticoids which results in Na+ & H2O retention. ADH decreases urine output. Stress response increases fluid volume, cardiac output, BP, perfusion to major organs. Exercise increases H2O loss via sweat. Fluid intake needs to be increased; with heavy exercise, ingested fluids should contain electrolytes.

Level of health

Stress response to surgery causes fluid balance changes in the 2nd and 5th postop days. Aldosterone, glucocorticoids, and ADH are increasingly secreted causing Na+ and Cl- retention, K+ excretion, and decreased urine output. Severe 2nd or 3rd degree burns cause fluid loss by one of five routes: Plasma leaves the intravascular spaces and becomes trapped as edema; plasma and interstitial fluids are lost as burn exudate; water vapor and heat are lost because burned skin is no longer a barrier; blood leaks from damaged capillaries; Na+ and H2O shift into cells. Cardiac output decreases perfusion to kidneys and urinary output. Client with cardiac problems retains Na+ & H2O causing edema, circulatory overload, and pulmonary edema. Failing kidneys cause abnormal buildup of Na+, Cl-, K+, and toxic ECF fluid. Acute renal failure is reversible; chronic renal failure can be treated with controlled diet, diuretics, and fluid restrictions. All types of fluid and electrolyte imbalances can be caused by cancers. Clients with cancer may develop third-spacing fluid accumulations that total body water but decrease ECF volume.
FLUID VOLUME DEFICIT

Etiologic Factors (R/T)
- Loss of H2O & Electrolytes as in: Vomiting, Diarrhea, Excessive laxative use, Fistulas, GI suction, Polyuria, Fever, Excessive sweating, Third-space fluid shifts
- Decreased intake, as in: Anorexia, Nausea, Inability to gain access to fluids, Inability to swallow fluids, Depression

Defining Characteristics (S&S)
- Weight loss over short period of time
  - ≥ 2% = 2½# loss in a 120# person-mild
  - ≥ 5% = 6# loss in a 120# person-moderate
  - ≥ 8% or more = 10# or more in a 120# person-severe
  - ↓'d skin and tongue turgor
- Dry mucous membranes
- Urine output ≥ 30 mL/hr in an adult
- Postural Hypotension (systolic BP ↓'s by ≥ 10 mm hg when client moves from lying to sitting or standing)
- Weak, rapid pulse
- Slow-filling peripheral veins
- ↓'d body temperature unless infection is present
- CVP ≥ 4 cm of water in vena cava
- BUN ↑'d out of proportion to serum creatinine
- ↑'d urine SG
- ↑'d Hct
- Flat neck veins when supine
- Marked oliguria
- Altered sensorium
- Cold extremities
- Sample subjective data
  - “After I got the flu I got so weak I couldn’t get out of bed...I think I was out of it for a couple of days.”
  - “I’m thirsty all the time.”
  - “I’ve been vomiting and I have diarrhea— several times a day.”

Nursing Interventions
- Assess for presence /worsening of FVD
- Give oral fluids if indicated
- Consider likes/dislikes
- Select bland fluids
- Offer fluids @ frequent intervals
- Explain need for fluid replacement
- Administer prn meds for nausea if applicable
- Consider the following in those with impaired swallowing:
  - Assess gag reflex
  - Position in upright position provide thick liquids
- If unable to eat/drink, discuss tube feedings with MD
- Consult with MD about IV’s
- Monitor response to fluid intake. If intake is adequate the client should:
  - ↑’d urine output (40-60 mL/hr in adult)
  - ↑’d BP toward normal
  - Return of pulse rate to baseline
  - Improved sensorium/sense of vitality
  - Improved skin and tongue turgor
X XI’d dryness of oral mucosa
X XI’d CVP toward normal
X Normal or no worse breath sounds
X XI’d urine SG
. Monitor clients with abnormal tendency to retain fluid (such as renal or cardiac clients) for signs of overload
. Turn client frequently, applying moisturizer
. Give frequent oral care

FLUID VOLUME EXCESS

Etiological Factors (R/T)

□ Compromised regulatory mechanisms:
X Renal failure
X Congestive heart failure (now called right sided pump failure)
X Cirrhosis of the liver
X Cushing’s syndrome
□ Overzealous administration of sodium-containing IV fluids
□ Excessive ingestion of sodium-containing substances in diet or sodium-containing medications

Defining Characteristics (S&S)

□ Weight gain over short period of time:
X 2% = 2.5# in a 120# person-mild
X 5% = 6# in a 120# person-moderate
X 8% or = 10# or in a 120# person-severe
□ Peripheral edema
□ Distended neck veins (JVD)
□ Distended peripheral veins
□ Slow-emptying peripheral veins
□ CVP 11 cm of water in the vena cava
□ Moist rales in the lung fields
□ Polyuria if renal function is normal
□ Ascites, pleural effusion (when FVE is severe, fluid transdates into body cavities)
□ XI’d BUN (due to plasma dilution)
□ XI’d Hct (due to plasma dilution)
□ Bounding, full pulse
□ Pulmonary edema, if severe
□ Sample subjective data:
X “I’ve noticed that my wedding ring is tight...also my clothes don’t fit as well as they used to. I guess I’ve gained some weight.”
X “Sometimes I can’t catch my breath and I feel like my heart is pounding away.”
X “I feel bloated.”
X Reports “dyspnea on exertion”, “feeling weak”, and “feeling fatigued”

Nursing Interventions

□ Assess for presence/worsening of FVE
□ Encourage adherence to Na+ restricted diet, if prescribed.
□ Assist dietician in diet instruction
□ Instruct clients requiring Na+ restriction to avoid OTC drugs w/o first checking with the Health-care advisor
□ When fluid retention persists despite adherence to dietary Na+ intake, consider hidden sources of Na+ such as water supply or use of water softeners
□ When indicated, encourage rest periods as lying down favors diuresis of edema
fluid
Monitor client's response to diuretics & discuss significant findings with MD
Monitor rate of IV fluids and client's response
Teach self-monitoring of weight and I & O measurements to clients with chronic retention (such as those with heart failure, renal disease, or liver disease)
Monitor for worsening of underlying cause of FVE
If dyspnea and/or orthopnea are present, position client so as to favor lung expansion (semi-Fowler's position)
Turn & position client frequently as edematous tissue is more prone to breakdown than normal tissue

THIRD-SPACING OF BODY FLUIDS

Definition: refers to a distributional shift of body fluid into a space from which it is not easily exchanged with the ECF
X Such spaces collect at the expense of the ECF and produce a deficit in the ECF volume
X The trapped fluid is unavailable for use by the body
X Fluid can be trapped in potential body spaces (pleural, peritoneal, or pericardial) or joint cavities. It can become trapped in the bowel by obstruction, in the interstitial space as edema after burns/trauma
X Third space fluid losses cannot be measured directly
X If the problem is bowel obstruction or edema from burns, the trapped fluid is eventually reabsorbed
X It can be mechanically removed when the problem is ascites or pleural effusion

Clinical Manifestations
X Are essentially those of FVD
< Tachycardia & hypotension r/t reduction of effective blood volume
< Urine volume ≤ 30 mL/hr in the adult r/t decreased plasma volume which causes reduced renal circulation and reduces urine formation
< [’d urine SG & osmolality r/t kidneys attempting to conserve needed water
< [’d HCT — falsely as RBC’s become suspended in smaller volume of plasma caused by fluid shift out of the intravascular space
< Postural hypotension
< Low CVP
< Poor skin turgor and tongue turgor
< *** Body weight changes are NOT significant

Clinical situations associated with Third-Spacing
X Acute intestinal obstruction — as much as 5-10 L or more can accumulate within the obstructed bowel
X Ascites — large quantities of water and electrolytes accumulate in the peritoneal cavities of client's with severe cirrhosis: removal via paracentesis only results in rapid reaccumulation
X Acute peritonitis — inflammatory exudate becomes trapped; as much as 4-6 L in a 24-hour period
X Pancreatitis — 6-10 L can accumulate in abdominal & retroperitoneal spaces
X Acute gastric dilation
X Pleural effusion
X Burns — in 1st 48-72 hours after severe burns, several L’s can be trapped in the interstitial space
X Crushing injuries
X Blockage of the lymphatic system
X Declamping phenomenon — fluid accumulates temporarily in the ischemic limb
X Hypoalbuminemia — ∴ d osmotic pull of plasma proteins causes movement of fluid into tissue spaces

X Fractured hip /pelvis — 1500-2000 mL of blood can be lost into surrounding tissues

Treatment

X Directed @ correcting the cause if possible

X Correct the reduced plasma volume before renal damage occurs

X Fluid replacement is with isotonic electrolyte solutions and colloids which replace plasma proteins

X Nursing assessment is directed at detecting FVD of third-spacing as these losses cannot be observed and measured and weight changes do NOT usually occur