Fluid, Electrolyte, and Acid-Base Balance

Total body fluids = 60% of body weight
- Extracellular Fluid Comp 20% of Total body wt.
  - Interstitial = 15% of total body wt.
  - Intravascular = 5% of total body wt.
  - Transcellular < 1% of total body wt.
  - H2O in connective tissue < 1%
- Intracellular Fluid Comp 40% total body wt.

Fluid Distribution ~ 40 liters
- Intracellular: 62.5%, 25 L
- Interstitial: 30%, 12 L
- Intravascular: 7.5%, 3 L

Distribution of Body Fluids

Compartments
- Intracellular (ICF): 2/3 of body fluid
- Extracellular (ECF): 1/3 of body fluid

Movement of Body Fluids
- Osmosis
  - Movement of water through a semipermeable membrane
- Diffusion
  - Movement of particles from high concentration to lower concentration
- Filtration
- Active transport
Composition of Body Fluids

Ion Distribution

<table>
<thead>
<tr>
<th>Cations</th>
<th>Anions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>Cl⁻</td>
</tr>
<tr>
<td>K⁺</td>
<td>PO₄⁻</td>
</tr>
</tbody>
</table>

Extracellular

Intracellular

Osmosis

Diffusion

Filtration

Active Transport
Osmolality and Osmolarity

- Osmolality: concentration of solute (particles) per kilogram of water.
- Osmolarity: concentration of solute (particles) per liter of a solution (the solvent does not have to be water).
- Osmotic pressure: pulling power of water.

Silly definition stuff

- Osmolarity = osmoles/L of solution
- Osmolality = osmoles/kg of solution

Where an osmole is 1 mole (6.02 x 10^23 particles)

The bottom line?
Use them synonymously!

Serum osmolality 275-295 milliosmoles/liter

- Estimated: 2 times the serum sodium level.
- Serum Osmolality = \( \frac{2 \times Na + BUN + GLU}{3 \times 18} \)

Tonicity

- Isotonic
- Hypertonic
- Hypotonic

Isotonic Solutions

- Same solute concentration as RBC
- If injected into vein: no net movement of fluid
- Example: 0.9% sodium chloride solution
  - aka Normal Saline

Hypertonic Solutions

- Higher solute concentration than RBC
- If injected into vein:
  - Fluid moves INTO veins
Hypotonic Solutions
- Lower solute concentration than RBC
- If injected into vein:
  - Fluid moves OUT of veins

Affects of Hypotonic Solution on Cell
- The [solute] outside the cell is lower than inside.
- Water moves from low [solute] to high [solute].
- The cell swells and eventually bursts!

Affects of Hypertonic Solution on Cell
- The [solute] outside the cell is higher than inside.
- Water moves from low [solute] to high [solute].
- The cell shrinks!

Regulating Body Fluids
- Fluid intake
  - Thirst
- Fluid output
  - Urine
  - Insensible loss
  - Feces
- Maintaining homeostasis
  - Kidneys
  - ADH
  - Renin-angiotensin-aldosterone system
  - Atrial natriuretic system

Figure 52-7: Factors stimulating water intake through the thirst mechanism.
Antidiuretic hormone (ADH) regulates water excretion from the kidneys.

Aldosterone (stimulated by the following):
- Inc. K+
- Decreased Na+
- Decreased blood vol.
- Decreased C.O.
- Decreased arterial BP
  - Triggers the Renin angio ald. System
- ^Absorption of Na+ ^Abs. H20
- ^excretion of K+ ^excretion of H ions

Glucocorticoids
- Released when body is stressed
  - Promote renal retention of sodium and water

Atrial natriuretic peptide (ANP)
- Causes vasodilation
- Suppression of renin-angiotensin system
- Decreases ADH release by pituitary gland causing increased urinary excretion of water
- Increases glomerular filtration rates inc urine production.

Brain natriuretic peptide (BNP)
- Stretch of cardiac ventricles
- BNP released
  - Vasodilates arteries and veins
  - Decreased release of aldosterone
  - Causes diuresis with excretion of both sodium and water

Regulating Electrolytes
- Sodium 135-145 mEq/L
- Potassium 3.5-5.0 mEq/L
- Calcium (total) 4.5-5.5mEq/L or 8.5-10.5mg/dL
- Calcium (ionized) 56% of total calcium (2.5mEq/L or 4.0-5.0mg/dL)
- Magnesium 1.5-2.5mEq/L or 1.6-2.5mg/dL
- Chloride 95-108mEq/L
- Phosphate 1.8-2.6mEq/L or 2.5-4.5mg/dL
- Bicarbonate 22-26mEq/L
**Fluid Volume Deficit**
- Isotonic Fluid loss
- Hypertonic Dehydration
- Third spacing

**Fluid Imbalances**
- Isotonic loss of water and electrolytes (fluid volume deficit)
- Isotonic gain of water and electrolytes (fluid volume excess)
- Hyperosmolar loss of only water (dehydration)
- Hypo-osmolar gain of only water (overhydration)

**Urine Specific Gravity**
- Urine 1.010-1.030

**Regulation of Acid-Base Balance**
- Low pH = acidic
- High pH = alkalinic
- Body fluids maintained between pH of 7.35 and 7.45 by
  - Buffers
  - Respiratory system
  - Renal system
Buffers

- Prevent excessive changes in pH
- Major buffer in ECF is HCO₃ and H₂CO₃
- Other buffers include:
  - Plasma proteins
  - Hemoglobin
  - Phosphates

Lungs

- Regulate acid-base balance by eliminating or retaining carbon dioxide
- Does this by altering rate/depth of respirations
  - Faster rate/more depth = get rid of more CO₂ and pH rises
  - Slower rate/less depth = retain CO₂ and pH lowers

Kidneys

- Regulate by selectively excreting or conserving bicarbonate and hydrogen ions
- Slower to respond to change

Factors Affecting Body Fluid, Electrolyte, and Acid-Base Balance

- Age
- Gender
- Body size
- Environmental temperature
- Lifestyle

Risk Factors for Fluid, Electrolyte, and Acid-Base Imbalances

- Chronic diseases
- Acute conditions
- Medications
- Treatments
- Extremes of age
- Inability to access food and fluids

Electrolyte Imbalances

- Hyponatremia
- Hypernatremia
- Hypokalemia
- Hyperkalemia
- Hypocalcemia
- Hypercalcemia
- Hypomagnesemia
- Hypermagnesemia
- Hypochloremia
- Hyperchloremia
- Hypophosphatemia
- Hyperphosphatemia
Acid-Base Imbalances
- Respiratory acidosis
- Respiratory alkalosis
- Metabolic acidosis
- Metabolic alkalosis

Collecting Assessment Data
- Nursing history
- Physical assessment
- Clinical measurement
- Review of laboratory test results
- Evaluation of edema

Evaluation of Edema

Diagram of Serum Electrolyte Results

NANDA Nursing Diagnoses
- Deficient Fluid Volume
- Excess Fluid Volume
- Risk for Imbalanced Fluid Volume
- Risk for Deficient Fluid volume
- Impaired Gas Exchange

NANDA Nursing Diagnoses
- Fluid and Acid-base Imbalances as Etiology
  - Impaired Oral Mucous Membrane
  - Impaired Skin Integrity
  - Decreased Cardiac Output
  - Ineffective Tissue Perfusion
  - Activity Intolerance
  - Risk for Injury
  - Acute Confusion
### Desired Outcomes
- Maintain or restore normal fluid balance
- Maintain or restore normal balance of electrolytes
- Maintain or restore pulmonary ventilation and oxygenation
- Prevent associated risks
  - Tissue breakdown, decreased cardiac output, confusion, other neurologic signs

### Nursing Interventions
- Monitoring
  - Fluid intake and output
  - Cardiovascular and respiratory status
  - Results of laboratory tests
- Assessing
  - Client’s weight
  - Location and extent of edema, if present
  - Skin turgor and skin status
  - Specific gravity of urine
  - Level of consciousness, and mental status

### Nursing Interventions
- Fluid intake modifications
- Dietary changes
- Parenteral fluid, electrolyte, and blood replacement
- Other appropriate measures such as:
  - Administering prescribed medications and oxygen
  - Providing skin care and oral hygiene
  - Positioning the client appropriately
  - Scheduling rest periods

### Promoting Fluid and Electrolyte Balance
- Consume 6-8 glasses water daily
- Avoid foods with excess salt, sugar, caffeine
- Eat well-balanced diet
- Limit alcohol intake
- Increase fluid intake before, during, after strenuous exercise
- Replace lost electrolytes

### Promoting Fluid and Electrolyte Balance
- Maintain normal body weight
- Learn about, monitor, manage side effects of medications
- Recognize risk factors
- Seek professional health care for notable signs of fluid imbalances

### Teaching Client to Maintain Fluid and Electrolyte Balance
- Promoting fluid and electrolyte balance
- Monitoring fluid intake and output
- Maintaining food and fluid intake
- Safety
- Medications
- Measures specific to client’s problems
- Referrals
- Community agencies and other sources of help
- Facilitating fluid intake
## Practice Guidelines
### Facilitating Fluid Intake
- Explain reason for required intake and amount needed
- Establish 24 hour plan for ingesting fluids
- Set short term goals
- Identify fluids client likes and use those
- Help clients select foods that become liquid at room temperature
- Supply cups, glasses, straws
- Serve fluids at proper temperature
- Encourage participation in recording intake
- Be alert to cultural implications

### Restricting Fluid Intake
- Explain reason and amount of restriction
- Help client establish ingestion schedule
- Identify preferences and obtain
- Set short term goals; place fluids in small containers
- Offer ice chips and mouth care
- Teach avoidance of ingesting chewy, salty, sweet foods or fluids
- Encourage participation in recording intake

## Correcting Imbalances
### Oral replacement
- If client is not vomiting
- If client has not experienced excessive fluid loss
- Has intact GI tract and gag and swallow reflexes

### Restricted fluids may be necessary for fluid retention
- Vary from nothing by mouth to precise amount ordered
- Dietary changes

## Oral Supplements
- Potassium
- Calcium
- Multivitamins
- Sports drink

## Evaluation
- Collect data as identified in the plan of care
- If desired outcomes are not achieved, explore the reasons before modifying the care plan
Question 1

An elderly nursing home resident has refused to eat or drink for several days and is admitted to the hospital. The nurse should assess for which of the following?

1. Increased blood pressure
2. Weak, rapid pulse
3. Moist mucous membranes
4. Jugular vein distention

Rationales 1

1. This option is indicative of fluid volume excess.
2. Correct. A client that has not eaten or drank anything for several days would be experiencing fluid volume deficit.
3. This option is indicative of fluid volume excess.
4. This option is indicative of fluid volume excess.

Question 2

A man brings his elderly wife to the emergency department. He states that she has been vomiting and has had diarrhea for the past 2 days. She appears lethargic and is complaining of leg cramps. What should the nurse do first?

1. Start an IV.
2. Review the results of serum electrolytes.
3. Offer the woman foods that are high in sodium and potassium content.
4. Administer an antiemetic.

Rationales 2

1. While the nurse may perform this intervention, assessment is needed initially.
2. Correct. Further assessment is needed to determine appropriate action.
3. While the nurse may this intervention, assessment is needed initially.
4. While the nurse may this intervention, assessment is needed initially.

Question 3

Which of the following client statements indicates a need for further teaching regarding treatment for hypokalemia?

1. “I will use avocado in my salads.”
2. “I will be sure to check my heart rate before I take my digoxin.”
3. “I will take my potassium in the morning after eating breakfast.”
4. “I will stop using my salt substitute.”

Rationales 3

1. Avocado is higher in potassium than most foods.
2. Hypokalemia can potentiate digoxin toxicity and checking the pulse will help the client to avoid this.
3. It is important to take potassium with food to avoid gastric upset.
4. Correct. Salt substitutes contain potassium. The client can still use it within reason.
Question 4

An elderly man is admitted to the medical unit with a diagnosis of dehydration. Which of the following signs or symptoms are most representative of a sodium imbalance?

1. Hyperreflexia
2. Mental confusion
3. Irregular pulse
4. Muscle weakness

Rationales 4

1. Because calcium contributes to the function of voluntary muscle contraction, this option is more appropriate for calcium imbalances.
2. Correct. Sodium contributes to the function of neural tissue.
3. Because potassium and calcium contribute to cardiac function, irregular pulse is more likely to be associated with those alterations.
4. Because calcium contributes to the function of voluntary muscle contraction, this option is more appropriate for calcium imbalances.

Question 5

A client is admitted to the hospital for hypocalcemia. Nursing interventions relating to which system would have the highest priority?

1. Renal
2. Cardiac
3. Gastrointestinal
4. Neuromuscular

Rationales 5

1. Incorrect.
2. Incorrect.
3. Incorrect.
4. Correct. The major clinical signs and symptoms of hypocalcemia are due to increased neuromuscular activity.