NMNEC Concept: **Fluid and Electrolyte Balance**

Mega Concept: Health and Illness

Category: Homeostasis and Regulation

Concept: Fluid and Electrolyte Balance

Concept Definition:
Factors that affect the process of body fluids and electrolyte regulation as well as conditions that contribute to imbalances.

Scope and Categories:
Fluid and electrolyte balance refers to a balance of intracellular volume (ICV) and extracellular volume (ECV) which includes interstitial fluid (ISF) and intravascular fluids. Fluid balance is maintained by hydrostatic pressures, osmolality or oncotic pressures (protein and plasma concentrations) and Electrolytes concentrations. Fluid and electrolyte balance is when these components are within normal physiologic range. An imbalance occurs when there is either an excess or deficit of any of these components:

- ECV is contained in the vascular and interstitial spaces.
  - Deficit: ↓ Na+ containing isotonic fluid
  - Excess: ↑ Na+ containing isotonic fluid
- Osmolality refers to the concentration of solutes in fluid.
  - Deficit: too dilute (↓ Na+)
  - Excess: too concentrated (↑ Na+)
- Hormonal responses influence movement of fluid:
  - Antidiuretic Hormone (ADH)
  - Aldosterone
  - Atrial Natriuretic Peptide (ANP)
- Electrolyte imbalances (deficit or excess) can occur alone or with ECV and/or osmolality imbalance. The primary electrolytes to focus on are:
  - Sodium: Key electrolyte in maintaining fluid balance; found primarily within extracellular space
  - Potassium: Cardiac rhythm, muscle contraction; found primarily within intracellular space
  - Calcium: Cardiac and neuromuscular function, coagulation, bone formation; reciprocal relationship with phosphorous
  - Magnesium: Neuromuscular function, bones, cardiac rhythm, blood pressure, immune system and glucose levels

- Phosphorous: Muscle, red blood cell, and nervous system function; ATP synthesis; acid-base buffering; reciprocal relationship with calcium

Risk Factors:
Fluid and electrolyte balance affects all individuals regardless of age, gender, race, or socioeconomic status.

Populations at Greatest Risk:
- Age: elderly and young
  - Elderly: decreased thirst, decline in renal function, decreased fluid reserve.
  - Infants and young children: Increased percentage of water, increased metabolic and respiratory rate, decreased fluid reserve, immature renal function.
- Significant health conditions or serious injury

Individual Risk Factors:
Conditions that cause imbalance: (see Felver, 2017, Box 8-1, p. 67, for more examples)
- Fluid and electrolyte output greater than intake and absorption:
  - Normal output but deficient intake or absorption
    - Such as anorexia, malabsorption problems
  - Increased output not balanced by increased intake
    - Such as vomiting, diarrhea
    - Diuretic therapy
    - Aldosterone
- Fluid and electrolyte output less than intake and absorption:
  - Output less than excessive or too rapid intake
    - Such as IV infusions, or eating too much salty food causing increased water intake
  - Decreased output not balanced by decreased intake
    - Such as oliguria from any cause
- Altered fluid and electrolyte distribution:
  - Rapid extracellular fluid (ECF) shift into "third space"
    - Such as ascites
  - Electrolyte shift from ECF into its electrolyte pool
    - Such as hypokalemia
  - Electrolyte shift from its electrolyte pool into ECF
    - Such as hyperkalemia

Physiologic Processes:
- Intake and absorption: The most common route of intake is oral. Thirst has a strong influence on intake. Factors affecting thirst include: increased osmolality, angiotensin II and baroreceptors. The

thirst sensation is blunted in the elderly. IV fluid and electrolytes enter the bloodstream directly. Ca++ and Mg++ are absorbed in the intestines. Calcium absorption is dependent on Vitamin D. Kidneys are involved in the reabsorption of phosphorous; levels of phosphorous depend on the balance of serum calcium.

- Distribution:
    - Fluid distribution between vascular and interstitial compartments occurs by filtration. Other factors that play a role in this distribution are hydrostatic and colloid osmotic pressures. Too much fluid in the interstitial compartment is called edema.
    - Water distribution between extracellular fluid and intracellular fluid. Cell membranes are semi-permeable, allowing water to readily pass, but is more difficult for sodium. Extracellular fluid can become too dilute or too concentrated, which can have clinical consequences (i.e. hypo or hypernatremia).
    - Electrolyte distribution: intra and extra cellular. Changing the ratio of electrolyte concentration can result in a change in the amount of physiologically active electrolytes, resulting in clinical manifestations.
- Output:
    - Normal excretory routes: urine, feces, skin and respiration
    - Abnormal routes: emesis, hemorrhage, tube/fistula drainage
    - Aldosterone acts on the kidneys to remove Na+ and water from the renal tubules and expands the ECV. Also facilitates renal excretion of K+.
    - Antidiuretic hormone (ADH) regulates renal excretion of water but not Na+.

Physiologic Consequences:

Imbalanced fluid and/or electrolytes can result in impaired:

- Perfusion and Oxygenation:
    - Hypovolemic shock
    - Pulmonary edema
    - Peripheral edema
    - Cardiac dysrhythmias
- Cerebral function:
    - Decreased level of consciousness
    - Seizures
- Neuromuscular function:
    - Muscle weakness or twitching and cramping
    - Hyperactive or depressed reflexes

Assessment:

Subjective:

- Elicit information about fluid and electrolyte intake and output (i.e. nutrition and fluid intake, elimination, medication history, kidney and liver function)
- Other concerning symptoms may include unexplained nausea, fatigue, dizziness, shortness of breath, muscle cramping, edema, acute weight changes.

Objective:

Clinical findings are evident based on the underlying condition and the specific fluid and/or electrolyte imbalance, which may include:

- Cardiovascular: Blood pressure, pulse strength and rhythm, jugular vein distension, ECG changes
- Respiratory: Breathing rate, rhythm, adventitious sounds
- Neurologic: Level of consciousness (LOC), orientation, pupillary response, voluntary movement of extremities, muscle strength, reflexes
- Skin: Turgor, condition of mucous membranes, edema
- Gastrointestinal: Bowel sounds, abdominal pain
- Genitourinary: Urine output, dilute vs. concentrated urine
- Musculoskeletal: Muscle strength, movement

Diagnostic Tests:

- Electrocardiogram (ECG)
- Serum osmolality and electrolytes
- Urine osmolality and specific gravity

Clinical Management:

Primary Prevention: Health Promotion

- Patient education on adequate fluid intake and nutrition

Secondary Prevention: Screening

- General screening to detect fluid and electrolyte imbalances is not routinely performed
- Monitoring serum blood levels may be performed as part of disease management

Tertiary Prevention: Correction of Imbalance

Collaborative Interventions:

- Fluid and electrolyte replacement
- Medication management (diuretics, vasopressin)
- Treatment of underlying cause

Nursing Interventions:

- Daily weights
- Monitoring and documenting accurate intake and output

- Safety
- Comfort measures
- Oral hygiene
- Education
- Monitor for potential complications

Interrelated Concepts:

- **Acid base Balance** is closely related to Fluid and Electrolyte Balance. For example, vomiting will result in changes related to both concepts. Electrolyte shifts occur in response to buffering excess hydrogen ion in acidosis.
- **Nutrition** is an essential component of intake, both food and fluid.
- **Elimination** alterations (bowel and renal) can disrupt fluid and electrolyte balance.

Depending on the fluid and electrolyte imbalance, these concepts may also be related:

- **Perfusion** and **Gas Exchang**e may be affected with extracellular volume disturbances
- **Cognition** may be affected if there are fluid and electrolyte disturbances such as hypo or hypernatremia.
- **Mobility**: Electrolyte imbalances may cause muscle weakness (potassium, calcium, magnesium).

Model Case:

Angelo Reyes* is a 40-year-old Hispanic architect. He was diagnosed with Diabetes Type 1 at age 13. His Diabetes is well controlled. Recently several of his coworkers had the flu. One morning he awoke feeling achy and tired. Though he went to work, he felt progressively worse throughout the day and went home midafternoon. Because he wasn't hungry, he ate a small meal and gave himself a reduced dose of insulin. By late evening he was vomiting and had a fever. Though he wasn't eating the next day, his glucose was elevated, but he was reluctant to take any insulin. After 2 days the nausea and vomiting subsided and he started urinating frequently. His wife took him to the hospital where he was diagnosed and treated for Diabetic Ketoacidosis (DKA) and dehydration (mucous membranes dry, Na+ 147). He was treated with fluids and insulin and discharged after almost 8 hours in the ED.

Angelo was at risk of Fluid and Electrolyte Imbalance because of his significant health condition (Diabetes). The flu (vomiting and decreased intake) created an imbalance because fluid and electrolyte output was greater than intake, resulting in dehydration. Diabetes complicated the situation which resulted in an Acid Base imbalance (DKA) [interrelated concept].

*Neighborhood (NBH) character ©

Exemplars:

New Mexico Nursing Education Consortium (NMNEC) Required Exemplars:

- Fluid Volume Deficit
- Chronic Kidney Disease (CKD)
    - CKD is a worldwide public health problem.
    - In the US, there is a rising incidence and prevalence of kidney failure, with poor outcomes and high cost.
    - Kidney disease is the ninth leading cause of death in the United States (Arora, 2018).
- Acute Kidney Injury (AKI)
    - AKI is present when one of the following criteria is met:
        - Serum creatinine rises by ≥ 26µmol/L within 48 hours or
        - Serum creatinine rises ≥ 1.5 fold from the reference value, which is known or presumed to have occurred within one week or
        - urine output is < 0.5ml/kg/hr for >6 consecutive hours
    - The reported prevalence of AKI from US data ranges from 1% (community-acquired) up to 7.1% (hospital-acquired) of all hospital admissions (The Renal Association, 2015)

Optional Exemplars:

- Burns
    - Burn Injuries Receiving Medical Treatment: 486,000
    - Fire /Smoke Inhalation Deaths Per Year: 3275
    - Hospitalizations for Burn Injury: 40,000, including 30,000 at hospitals with burn centers (nearest 5,000) (American Burn Association, 2016)

References:

American Burn Association (2016). *Burn incidence and treatment in the United States: 2016.* Retrieved from http://www.ameriburn.org/resources_factsheet.php

Arora, P. (2018). Chronic kidney disease. *Medscape*. Retrieved from http://emedicine.medscape.com/article/238798-overview#a0101

Felver, L. (2017). Fluid and electrolyte balance. In J.F. Giddens (Ed.), *Concepts for Nursing Practice* (2nd ed.) (pp. 62-74). St. Louis, MO: Mosby Elsevier.

The Renal Association. (2015). Acute kidney injury and intravenous fluid therapy. Retrieved from https://renal.org/wp-content/uploads/2017/07/acute_care_toolkit_12_aki_web.pdf

Resources:

Giddens, J. F. (2010). *The neighborhood: Faculty navigation guide*. Boston: Pearson Prentice Hall.

Harding, M.M. (2017). Fluid, electrolyte, and acid-base imbalances. In Lewis, S.L., Bucher, L., Heitkemper, M.M., and Harding, M.M. (Eds.) *Medical-surgical nursing: Assessment and management of clinical problems* (10th ed.) (pp 270-299). St. Louis, MO: Elsevier.

NIH US National Library of Medicine: *Medline Plus. Electrolytes*: http://www.nlm.nih.gov/medlineplus/ency/article/002350.htm