Fluid and Chemical Balance

Learning Objectives

On completion of this chapter, the reader will

- Name four components of body fluid.
- List five physiologic transport mechanisms for distributing fluid and its constituents.
- Name 10 assessments that provide data about a client's fluid status.
- Describe three methods for maintaining or restoring fluid volume.
- Describe four methods for reducing fluid volume.

Body fluid is a mixture of water, chemicals called electrolytes and nonelectrolytes, and blood cells. Water, vehicle for transporting the chemicals, is the very essence of life. Because water is not stored in any great reserve, daily replacement maintain survival.

A. BODY FLUID

1. Water

The human body is approximately 45% to 75% water. Body water is supplied and replenished from 3 sources: **drinking liquid**, **consumed food** & **metabolizing nutrients**. Once the water is absorbed, it is distributed among various locations, called **compartments**, within the body.

2. Fluid Compartments

1. **Intracellular fluid (ICF):** (inside cells) the greatest proportion of water.
2. **Extracellular fluid (ECF)** (fluid outside cells). **ECF** is subdivided into:
   - ✓ **Interstitial fluid** (fluid in the tissue space between and around cells)
   - ✓ **Intravascular fluid** (watery plasma, or serum, portion of blood).

Percentages Of Body Fluid According To Age And Gender				
Fluid Compartment	**Infants**	**Adult Men**	**Adult Women**	**Elderly**
Intravascular	4%	4%	5%	5%
Interstitial	25%	11%	10%	15%
Intracellular	48%	45%	35%	25%
Total	77%	60%	50%	45%

3. Electrolytes

Electrolytes are ***chemical compounds*** that are ***dissolved***, ***absorbed***, and ***distributed*** in ***body fluid*** and **possess *an electrical charge***.

- ✓ They are **obtained** from ***dietary sources*** of food & beverages.
- ✓ They are **essential** for ***maintaining cellular***, ***tissue***, ***organ functions***.
- ✓ **Electrolytes** affect ***fluid balance*** and ***complex chemical activities*** as ***muscle contraction*** and the ***formation of enzymes***, ***acids***, and ***bases***.
- ✓ **Electrolytes** are called **ions**. **Cations** (***positive charge***) and **anions** (***negative charge***) are present in ***equal amounts*** overall but their ***concentrations vary*** in each body fluid ***compartment***. Ex, more potassium ions are inside cells than outside cells.
- ✓ **Electrolyte** are measured in serum of blood & reported in *milliequivalents* (mEq).

- ✓ **An electrolyte imbalance** occurs when **cations** or **anions** become excessive or deficient. Significant imbalances can lead to ***dangerous physiologic problems***.

MAJOR SERUM ELECTROLYTES				
Electrolyte	**Chemical Symbol**	**Cation/Anion**	**Normal Serum Level**	**Predominant Compartment**
Sodium	Na	Cation	135–148 mEq/L	ECF
Potassium	K	Cation	3.5–5.0 mEq/L	ICF
Chloride	Cl	Anion	90–110 mEq/L	ECF
Phosphate	PO4	Anion	1.7–2.6 mEq/L	ICF
Calcium	Ca	Cation	2.1–2.6 mEq/L	ICF
Magnesium	Mg	Cation	1.3–2.1 mEq/L	ICF
Bicarbonate	HCO3	Anion	22–26 mEq/L	ICF
ECF, extracellular compartment; ICF, intracellular compartment				

4. Nonelectrolytes

Nonelectrolytes are chemical compounds that ***remain bound*** together when ***dissolved*** in a solution and ***do not conduct electricity***.

- **Nonelectrolytes** are supplied from the chemical end-products of ***carbohydrate***, ***protein***, and ***fat metabolism*** namely ***glucose***, ***amino acids***, and ***fatty acids***.
- **Stable amount of nonelectrolytes**: when person consumes adequate nutrients.
- **Deficiency states:** when ***body fluid is lost*** or when ability to ***eat is compromised***.

5. Blood

It consists of ***3 liters of plasma***, or fluid, & ***2 liters of blood cells*** for a total volume of ***5.*** Blood cells include **erythrocytes** (RBCs); **leukocytes** (WBCs); & **platelets**.

- For every 500 red blood cells, there are ≈ 30 platelets and 1 white blood cell.
- **Deficits in fluid or cell volume** are treated by administering ***fluid***, ***whole blood*** or ***packed cells***, or ***individual blood components***.

6. Fluid and Electrolyte Distribution Mechanisms

1. Osmosis

Osmosis influence the w*ater movement** from area where fluid is ***more dilute to another where fluid is ***more concentrated*** **through a semipermeable membrane that *surrounding body cells*, *capillary walls***, and ***body organs and cavities***.

Osmosis is influenced by the ***presence & quantity of colloids*** on either membrane side. **Colloids** are undissolved protein as **albumin** & **blood cells** within body fluids.

2. Filtration

Filtration regulates the water and substances movement from a compartment where the **pressure is higher** to one where the **pressure is lower**. **Example:** at the **arterial end of a capillary**& **interstitial compartment**. Filtration also governs how **kidney excretes fluid** and wastes then reabsorbs water and substances.

3. Passive Diffusion

Passive diffusion is the physiologic process in which **dissolved substances**, as electrolytes and gases, move from an area of **higher concentration** to area of **lower concentration** through semipermeable membrane. It facilitates **electrochemical neutrality** (identical balance of **cations with anions**) in any given compartment.

4. ***Facilitated Diffusion***

   Facilitated diffusion is the process in which certain dissolved substances ***require assistance*** of ***carrier molecule*** to pass from one side of a semipermeable membrane to another. It also ***regulates chemical balance***. It distributes substances from **higher concentration** to **lower** area. **Example**: **Insulin** is **glucose** carrier substance

5. ***Active Transport***

   It is a process of chemical distribution that ***requires an energy source***, involves a substance called ***adenosine triphosphate (ATP)***. ATP provides energy to drive dissolved chemicals against concentration gradient. It allows chemical distribution from an area of **low concentration** to **higher**. **Example**: ***sodium-potassium pump system*** on cellular membranes, which regulates the movement of ***potassium*** from ***lower concentrations*** in ***ECF*** **into** ***cells*** where it is more highly concentrated. It also moves ***sodium***, from lower concentration ***within cells*** to ***ECF***.

Conditions that Predispose to Fluid Imbalances	
FLUID DEFICIT	**FLUID EXCESS**
● Starvation ● Vomiting ● Diarrhea ● Gastric suction ● Hemorrhage ● Major burns ● Laxative abuse ● Potent diuretics ● Impaired swallowing ● Draining wounds ● Fever and sweating ● Exercise and sweating ● Environmental heat and humidity	● Kidney failure ● Pregnancy ● Heart failure ● Rapid administration of IV fluid or blood ● Administration of albumin ● Corticosteroid drug therapy ● Excessive intake of sodium ● Premenstrual fluid retention

6. **Fluid Regulation**

   In healthy adults averages **fluid intake** is **2500 mL** (***1800-3000 mL/day***) with a ***similar*** volume of **fluid loss**. Normal mechanisms for **fluid loss** are ***urination***, ***bowel elimination***, ***perspiration***, & ***breathing***. ***Insensible losses*** **from skin** other than sweat glands and **vapor in exhaled air**. Several mechanisms maintain a match between fluid intake & output. **Example**, as body fluid becomes concentrated, brain triggers **thirst** sensation, which ***stimulates person to drink***. As fluid expands, **kidneys excrete** a proportionate volume of water to maintain or restore balance.

DAILY FLUID INTAKE AND LOSSES			
SOURCES OF FLUID		**MECHANISMS OF FLUID LOSS**	
Oral liquids	1,200–1,500 mL/day	***Urine***	1,200–1,700 mL/day
Food	700–1,000 mL/day	***Feces***	100–250 mL/day
Metabolism	200–400 mL/day	***Perspiration*** Insensible losses ***Skin***	100–150 mL/day 350–400 mL/day

		Lungs	350–400 mL/day
Total	2,100–2,900 mL/day	**Total**	2,100–2,900 mL/day
Average intake	2,500 mL/day	**Average loss**	2,500 mL/day

B. FLUID VOLUME ASSESSMENT

Assess fluid status using physical assessment & measurement of intake & output (I&O)

Generally clients placed automatically on (I&O) include clients who:

▪ Clients with intravenous fluids	▪ Clients receiving tube feedings
▪ Clients with wound drainage or suction	▪ Clients with diuretic drug therapy
▪ Clients undergone surgery, until sufficient eating, drinking & voiding	
▪ Clients with urinary catheters, until output is adequate or void after removal	
▪ Clients with an actual or potential fluid imbalance problem.	

1. **Fluid Intake** includes

- All the **liquids a client drinks**
- The liquid equivalent of **melted ice chips**, which is half of the frozen volume
- **Liquid Foods** such as gelatin, ice cream, and thin cooked cereal
- **Fluid infusions** such as IV solutions
- **Fluid instillations** as (**feeding tubes** or **tube irrigations)**

  Fluid volumes are recorded in **milliliters (mL)** or **cubic centimeters (cc)**. Nurse **subtotals and documents amounts at the end of each shift** or more frequently.

2. **Fluid Output**

- Fluid output is the sum of liquid eliminated from body including: ***Urine***; ***Emesis*** (vomitus); ***Blood loss***; ***Diarrhea***; ***Wound*** or ***tube drainage*** & ***Aspirated irrigations***.
- If accurate assessment is critical to a client's treatment, the nurse ***weighs wet linens***, ***pads***, ***diapers***, or ***dressings*** and **subtracts** the **weight of a similar dry item**.
- Inform clients about fluid replacement or restriction purpose & ways they can assist.

Signs of fluid imbalance		
Assessment	**Fluid deficit**	**Fluid excess**
Weight	Weight loss ≥2 lbs/24 hr	Weight gain ≥2 lbs/24 hr
Blood pressure	Low	High
Temperature	Elevated	Normal
Pulse	Rapid, weak, thready	Full, bounding
Respirations	Rapid, shallow	Moist, labored
Urine	Scant, dark yellow	Light yellow
Stool	Dry, small volume	Bulky
Skin	Warm, flushed, dry; Poor skin turgor	Cool, pale, moist; Pitting edema
Mucous membrane	Dry, sticky	Moist
Eyes	Sunken	Swollen
Lungs	Clear	Crackles, gurgles
Breathing	Effortless	Dyspnea, orthopnea

Energy	Weak	Fatigues easily
Jugular neck veins	Flat	Distended
Cognition	Reduced	Reduced

Volume Equivalents for Common Containers	
Volume (mL)	**Container**
Teaspoon	5
Tablespoon	15
Juice glass	120
Drinking glass	240
Coffee cup	210
Milk carton	240
Water pitcher	900
Paper cup	180
Soup bowl	200
Cereal bowl	120
Ice cream cup	120
Gelatin dish	90



Calibrated containers used to measure liquid volumes.

Calculate volume of fluid intake for the following: glass of orange juice, half-pint carton of milk, bowl of tomato soup, dish of lime jello, cup of coffee, 100 mL infusion of IV antibiotic solution.

C. COMMON FLUID IMBALANCES

It is a condition in which body's water is not in **proper volume** or **location** within body. It include ***hypovolemia***, ***hypervolemia*** & ***third-spacing***.

1. Hypovolemia

Hypovolemia is a ***low volume*** in ***ECF compartments***. If untreated, results in **dehydration**. **Mild dehydration** (3%-5%) loss of body weight; **moderate dehydration** (***6%-10%) loss*** & **severe dehydration**, life-threatening emergency, with a loss of **> 9%-15% of body weight**.

Inadequate fluid intake

1. **Fluid loss** in **excess of fluid intake**
2. **Translocation** of **intravascular fluid** to **interstitial compartment** or ***peritoneal cavity***, ***pericardium***, & ***pleural space***. **Fluid balance restored** by treating cause of ***hypovolemia***, ↑**oral intake**, ***IV fluid***, ***control fluid losses***, or a **combination**.

2. Hypervolemia

Means ***higher-than-normal volume of water*** in ***intravascular fluid compartment***. **Edema** develops when **excess fluid** is distributed to **interstitial space**. It occur when **3-liter excess** in body fluid. Hypervolemia can lead to **circulatory overload**.

Fluid balance is restored by:

▪ **Administering diuretic drugs**	▪ **Treating the cause**
▪ **Discontinuing** or reducing **IV fluid infusions**	▪ **Restricting oral fluids**
▪ Using a **combination** of these interventions	▪ **Reduce salt consumption**

Foods high in salt (sodium)

▪ Processed meats as frankfurters and cold cuts	▪ Peanut butter
▪ Dairy products, especially hard cheese	▪ Smoked fish
▪ Powdered cocoa or hot chocolate mixes	▪ Baking mixes
▪ Tomato and tomato–vegetable juice	▪ Salted snack foods
▪ Canned soup and bouill Pickles	▪ Boxed casserole mixes
▪ Canned vegetables, especially sauerkraut	▪ Frozen egg substitutes
▪ Seasonings as catsup, gravy mixes, soy sauce, pickle relish, tartar sauce	

3. **Third-Spacing**

   It is the ***movement of intravascular fluid*** to ***nonvascular compartments***. It is **manifested** by ***tissue swelling*** or ***fluid accumulation*** in cavities as **peritoneum**. It is **associated** with **hypoalbuminemia** caused by: ***liver disease***, ***chronic kidney disease***, alterations in ***capillary*** & ***cellular permeability*** as ***burns*** & ***severe allergy***.

Depletion of intravascular fluid may lead to ***hypotension*** & ***shock*** & require fluid therapy. **Priority** is by providing ***IV fluids***, in large volumes ***at rapid rates***. **Blood transfusions** or **albumin** to ***restore colloidal osmotic pressure*** & ***pull fluid back*** into intravascular space.

Measuring Intake and Output (I&O)

Introduction

To maintain good health, fluid intake should approximately equal fluid output. Intake that exceeds output can indicate medical conditions ranging from renal failure to congestive heart failure. Output that exceeds intake can be caused by diarrhea or by using diuretic medications. Generally clients who are receiving fluids other than oral or who are losing fluids other than voiding are placed on intake and output measurement. Clients with conditions that affect fluid balance, i.e., diabetes, renal failure, diuretic therapy, or anorexia also require I&O monitoring.

Time Allowed:

Estimated time to complete the skill: 5–10 minutes

Practical skills outcomes: at the end of the procedure the student will be able to accurately measure intake and output (i&o)

Definitions & terminology:

- Intake and Output: Is the recording of intake and output data for a 24-hour period to assess for an actual or potential fluid imbalance.
- Dehydration: A condition resulting from excessive loss of body fluid that occurs when fluid output exceeds intake.
- Fluid balance: fluid intake equal fluid loss
- Fluid retention: accumulation of fluid into the body
- Intake: is any fluid consumed or infused.
- Output: is any fluid lost, drained or excreted from the body.

Indications

- Helps control fluid balance
- Provides data to evaluate the effects of therapy, such as diuretics or rehydration
- To monitor the client's fluid status over a 24-hour period

Safety precautions

- Wash hands and wear gloves to protect against exposure to body fluids.

Quality control

- Pureed food is not considered to be fluid intake.
- Bottled nutrient tube feedings are liquid and must be considered in I&O.
- Record measurements immediately not at the end of the shift.
- All postoperative clients are at risk for fluid loss through blood or plasma from their incision sites.
- Fluids taken to swallow pills must be recorded as intake.
- Do not allow family members empty bedpans, or catheter bags.
- Explain the rationale and procedure for monitoring I&O.

Source of adult average daily fluid intake

Source	Amount (mL)
Water consumed as fluids	1500
Water present in food	750
Water produced by oxidation	350
Total	2600

Average daily water requirements by age and weight

Age	Water requirement mL	mL/kg body weight
3days	250-300	80-100
1 year	1150-1300	120-135
2 years	1350-1500	115-125
4 years	1600-1800	100-110
10 years	2000-2500	70-85
14 years	2200-2700	50-60
18 years	2200-2700	40-60
Adult	2400-2600	20-30

Average daily fluid output for adult

Route	Amount (mL)
Urine	1400-1500
Insensible losses	
Lungs	350-400
skin	350-400
Sweat	100
Feces	100-200
Total	2300-2600

Instruments & materials

- I&O form at bedside
- I&O graphic record in chart
- Glass or cup
- Bedpan or urinal or bedside commode
- Nonsterile gloves
- Graduated measuring container, as 1,000-mL container, water pitcher, or cups
- Scale
- Felt-tipped pen or fine-tip marker

Figure 5.5 Fluid balance chart

Name: Date:

	Intake				Output				
Time	Intravenous fluid	Peg/parenteral nutrition	Oral intake		Vomit/gastric aspirate	Urine	Drains	Stoma	
				cum. total					cum. total
01									
02									
03									
04									
05									
06									
07									
08									
09									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
TOTAL									

Total intake = ...Total output = ...

Instructions

Oral fluid .....Dietary intake .....

Procedures (implementation)

Assessment

1. Assess the client's risk factors for fluid overload, such as congestive heart failure, renal failure, or ascites. Edema can result from excess volume in extracellular spaces & transferring of fluid into tissues.
2. Determine if the client is receiving fluids or medications that would predispose him to fluid overload such as large amounts of IV fluids or steroid therapy. Steroids cause sodium and water retention and excretion of potassium.
3. Assess the client's risk factors for fluid loss such as diaphoresis, rapid respirations, diarrhea, gastric suction, blood loss, or wound drainage. Dehydration can result from reduction of fluid within the tissues and circulatory system.

4. Determine if the client's urine output is in excess of his fluid intake. Kidneys excrete excess fluid during periods of overhydration and conserve body water during periods of dehydration.

5. Assess the client's ability to understand and cooperate with intake and output measurement. Cooperation in these measurements will help ensure accuracy.

Nursing Diagnoses

- Fluid Volume Excess.
- Fluid Volume Deficit.
- Risk for Fluid Volume Deficit.

Planning: Outcome identification and planning

1. The client's fluid I & O will be accurately measured & recorded.
2. Client will participate in recording of fluid intake and output to the best of his ability.

Client education needed

1. Instruct how to measure fluid intake using standardized volumes of glassware & dishes.
2. Teach the client which intake is considered to be fluid and which is not. Remind the client what is considered fluid intake, e.g., coffee, tea, and soda pop, as well as gelatin, ice cream, and Popsicles.
3. Teach the client to measure and record the amount of fluid his standard utensil hold and then to use those utensils exclusively.
4. Instruct client to void into a bedpan or urinal, not into a toilet.
5. Teach client to dispose of toilet tissue in a plastic lined container, not in the bedpan.

Implementation

Action	Rationale
1. Wash hands.	Reduces microorganism's transmission.
2. Explain rules of I & O record. All oral fluids must be recorded on the client's I&O form. • Client must void into bedpan or urinal, not into toilet. • Toilet tissue should be disposed of in plastic-lined container, not in bedpan.	2. Elicits patient support. • Fluid voided into the toilet cannot be measured. • Liquids absorbed into toilet tissue cannot be measured by volume.
 Bedpan and urinal, protective pad, and graduated specimen container	 Graduated specimen container is used to measure urine, drainage, or other output.

3. Measure all oral fluids in accord with agency policy; e.g., cup = 150 ml, glass = 240 ml. Record all infused IV fluids.	3. Provides for consistency of measurement.
	
4. Record time and amount of all fluid intakes in the designated space on bedside form (oral, tube feedings, IV fluids).	4. Documents fluids.
5. Transfer 8-hour total fluid intake from bedside I&O record to graphic sheet or 24-hour I&O record on client's chart.	5. Provides for data analysis of client's fluid status.
6. Record all forms of intake, except blood and blood products, in the appropriate column of the 24-hour record.	6. Documents intake by type and amount.
7. Complete 24-hour intake record by adding all 8-hour totals.	7. Provides consistent data for analysis of client's fluid status over a 24-hour period.
Output	
8. Apply nonsterile gloves.	8. Reduces transmission of pathogens.
9. Empty urinal, bedpan, or Foley drainage bag (see Figure 1-7-6) into graduated container or commode "hat".	9. Provides accurate measurement of urine.
 Urine in Foley drainage bag must be measured.	 Empty urine into a graduated container to measure.
10. Remove gloves, and wash hands.	Prevents cross-contamination.
11. Record time and amount of output (urine, drainage from nasogastric tube, drainage tube) on bedside I&O record.	Documents output.

12. Transfer 8-hour output totals to graphic sheet or 24-hour I&O record on the client's chart.	Provides for data analysis of client's fluid status.
13. Complete 24-hour output record by totaling all 8-hour totals.	Provides consistent data for analysis of client's fluid status over a 24-hour period.
14. Wash hands	Reduces microorganism's transmission.
Evaluation	

- The client's fluid intake and output was accurately measured and recorded.
- Note if the client was able to participate in the recording of fluid intake and output to the best of his ability.
- Note and report any abnormal findings to the client's physician or qualified practitioner.

Documentation

The following should be noted on the client's Intake and Output chart:

- Record all fluid intake and output.
- Add totals for 24 hours.
- Add totals at the end of every shift.
- Record intake from all sources on appropriate graph sheet
- Record output from all sources on appropriate graph sheet
- Record medication or fluid given to improve fluid balance and immediate response noted (e.g., diuresis, blood pressure increase)
- Vital signs and skin turgor status indicating fluid balance or imbalance, including measurements of edematous areas
- Client weight, as indicated by frequency of orders
- Any unusual findings, excessive intake, excessive output, or serious imbalance of intake and output should be documented and reported to the patient's physician or qualified practitioner.