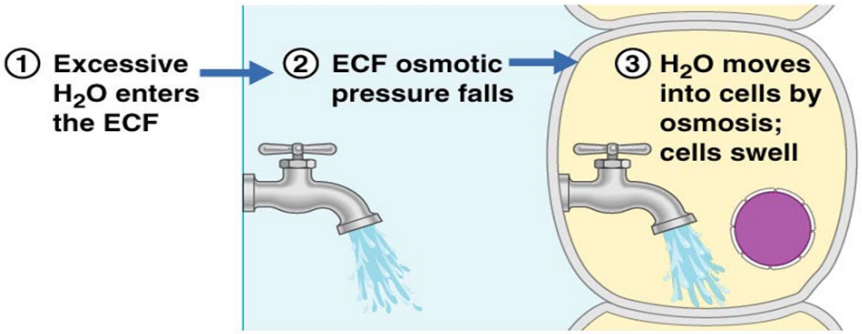
Fluids and electrolytes

balance and imbalances

(a) Mechanism of dehydration



(b) Mechanism of hypotonic hydration

Introduction

- Nurses need understanding of the physiology of fluid and electrolyte balance and acid–base balance to anticipate, identify, and respond to possible imbalances. Nurses also must use effective teaching and communication skills to help prevent and treat various fluid and electrolyte disturbances.

Amount and Composition of Body Fluids

- Body fluid is located in two fluid compartments: intracellular space (fluid in the cells) and extracellular space (fluid outside the cells). Approximately two thirds of body fluid are in the intracellular fluid (ICF) compartment. Approximately one third is in the extracellular fluid (ECF) compartment.

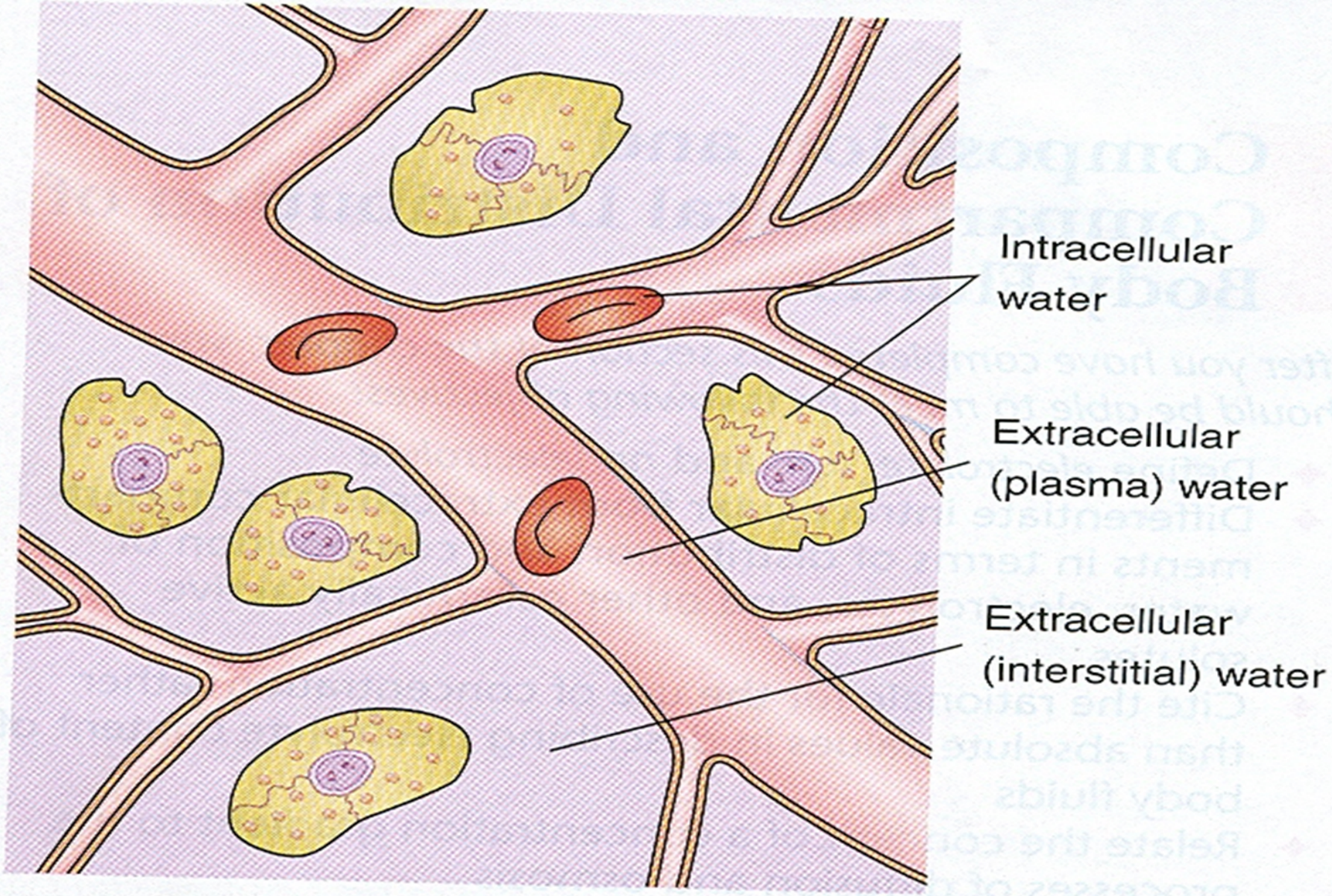
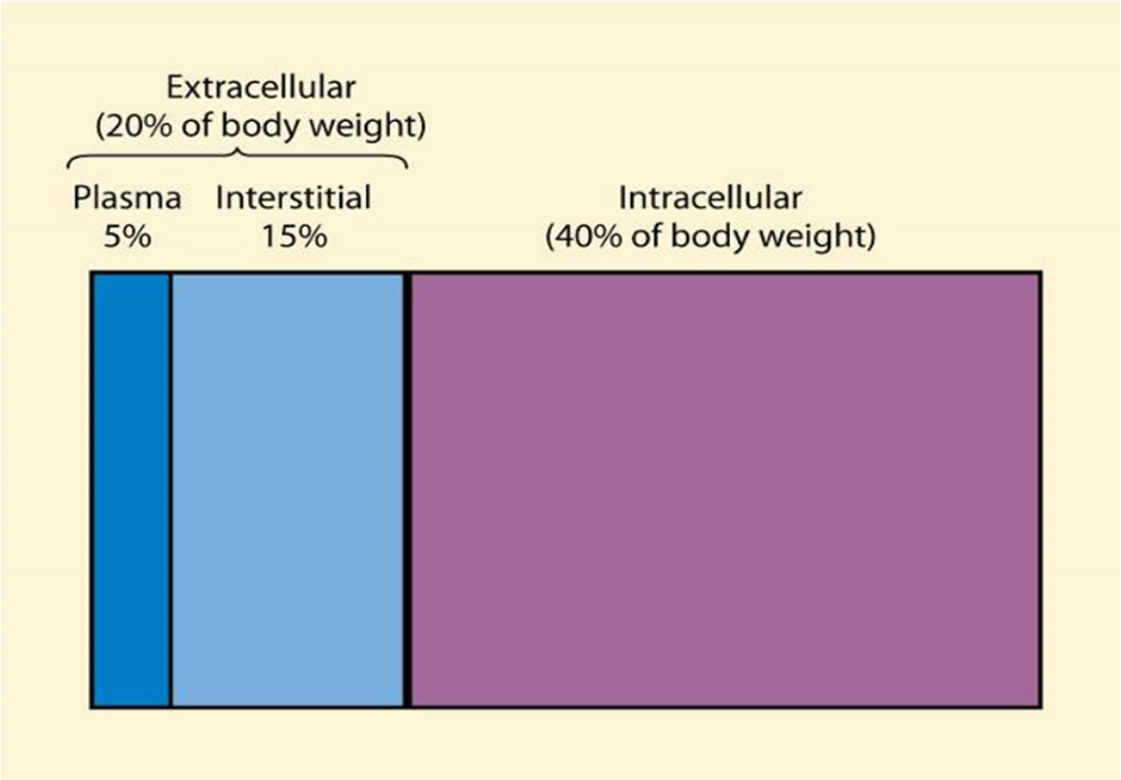


FIGURE 31-1 Distribution of body water. The extracellular space includes the vascular compartment and the interstitial spaces.

Amount and Composition of Body Fluids

- Approximately 60% of the weight of an adult consists of fluid (water and electrolytes).



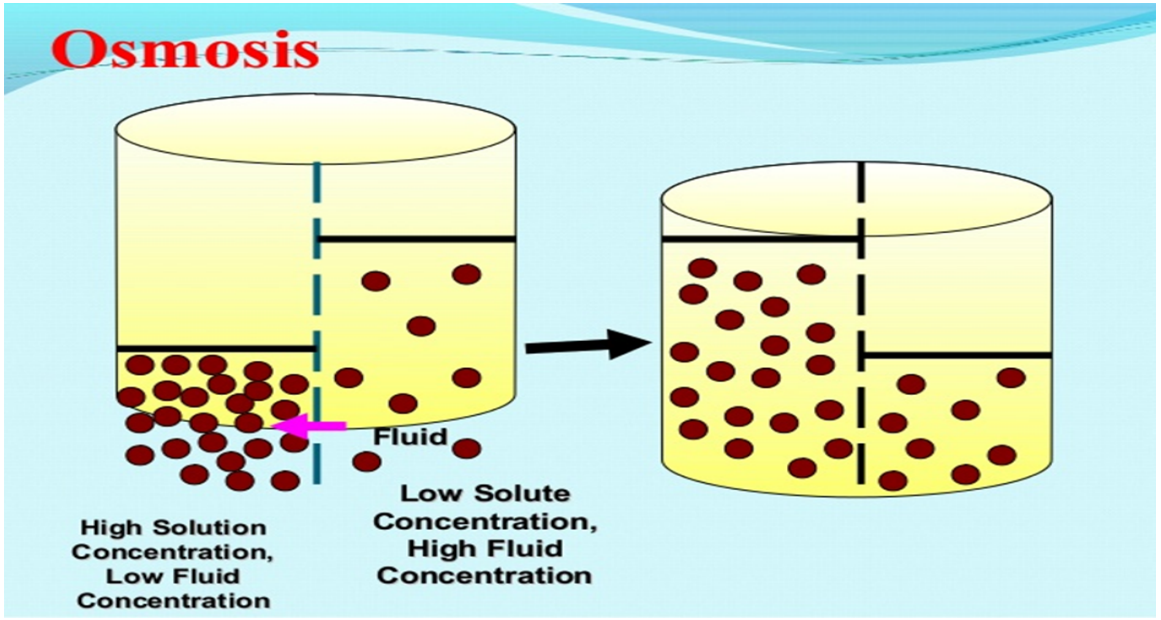
Electrolytes

- Electrolytes in body fluids are active chemicals (cations that carry positive charges and anions that carry negative charges). major cations in body fluid are sodium, potassium, calcium, magnesium, and hydrogen ions. major anions are chloride, phosphate, and sulfate ions.

Regulation of Body Fluid Compartments

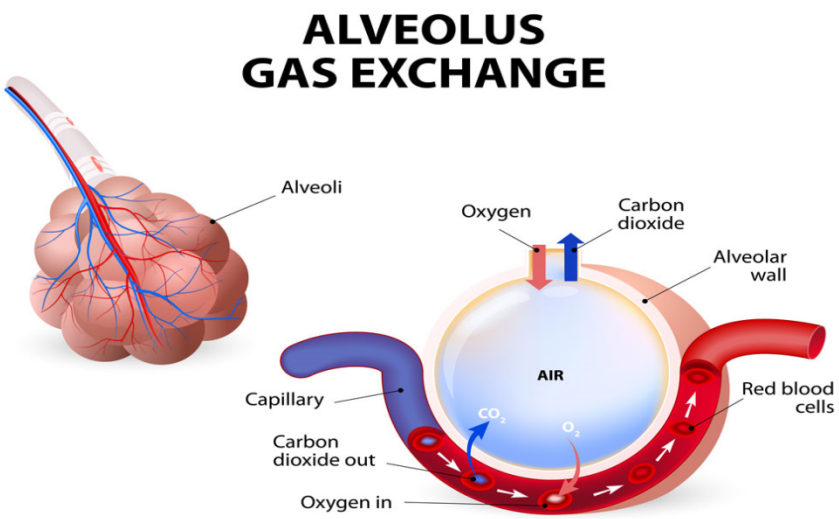
Osmosis

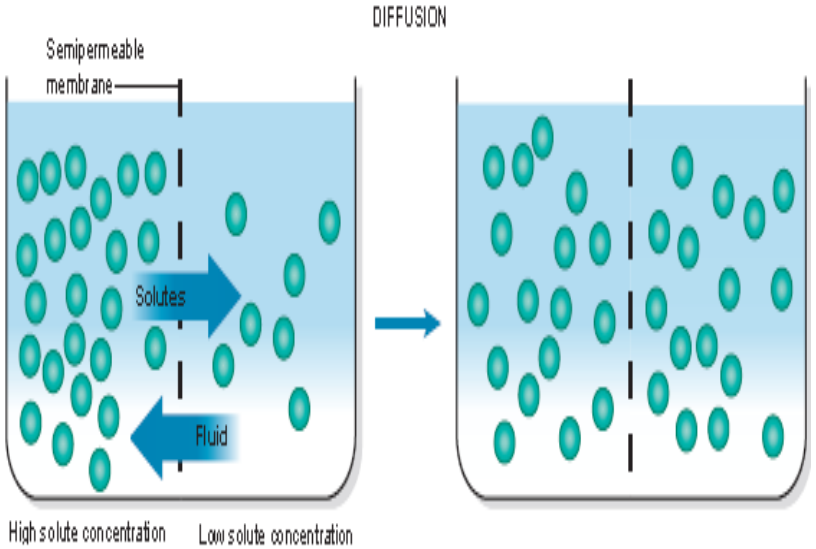
Movement of water (or other solute) from an area of lesser solute concentration to one of greater solute concentration



Diffusion

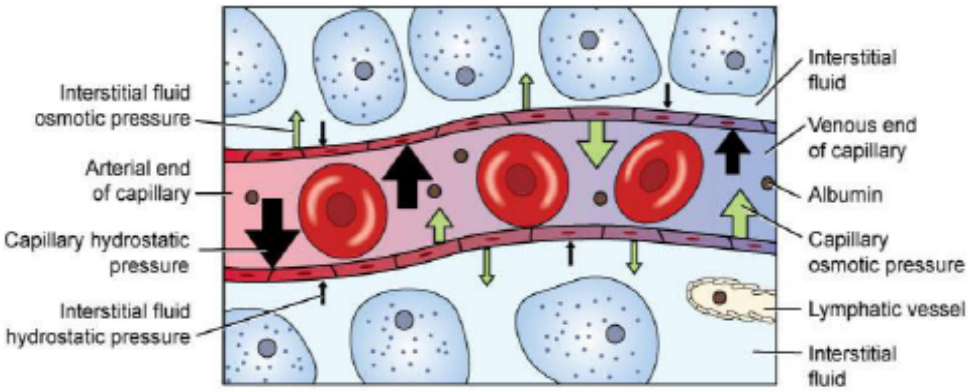
- Passive movement of electrolytes or other particles down concentration gradient (from higher to lower concentration). Examples: exchange of O2 and CO2 between the pulmonary capillaries and alveoli.





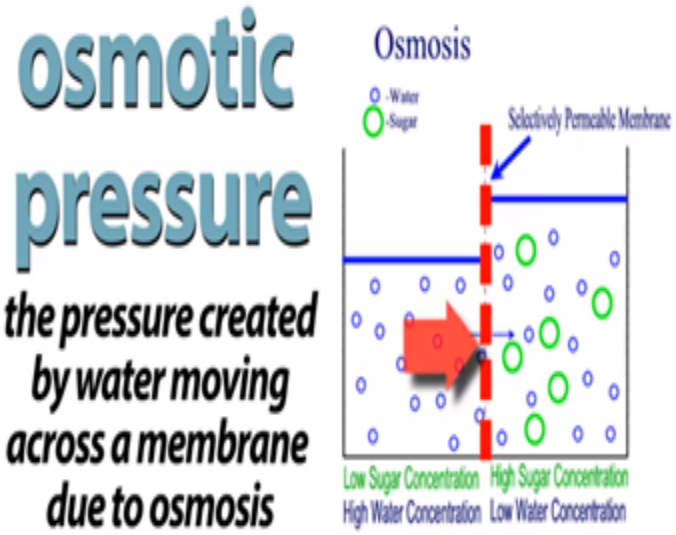
Filtration

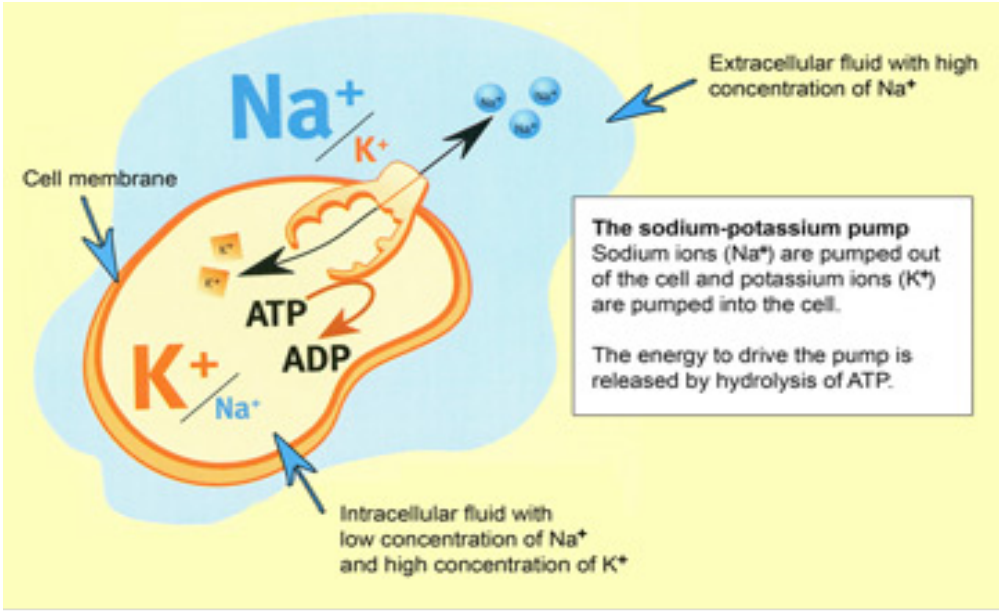
- Movement of water and solutes from an area of high hydrostatic pressure (in the capillaries) to lower hydrostatic pressure, hydrostatic pressure results from the pumping action of the heart. Example: the kidneys filter approximately 180 L of plasma per day.



Active transport

- Active transport is movement of ions against osmotic pressure to an area of higher pressure; it requires energy. Example: sodium potassium pump.

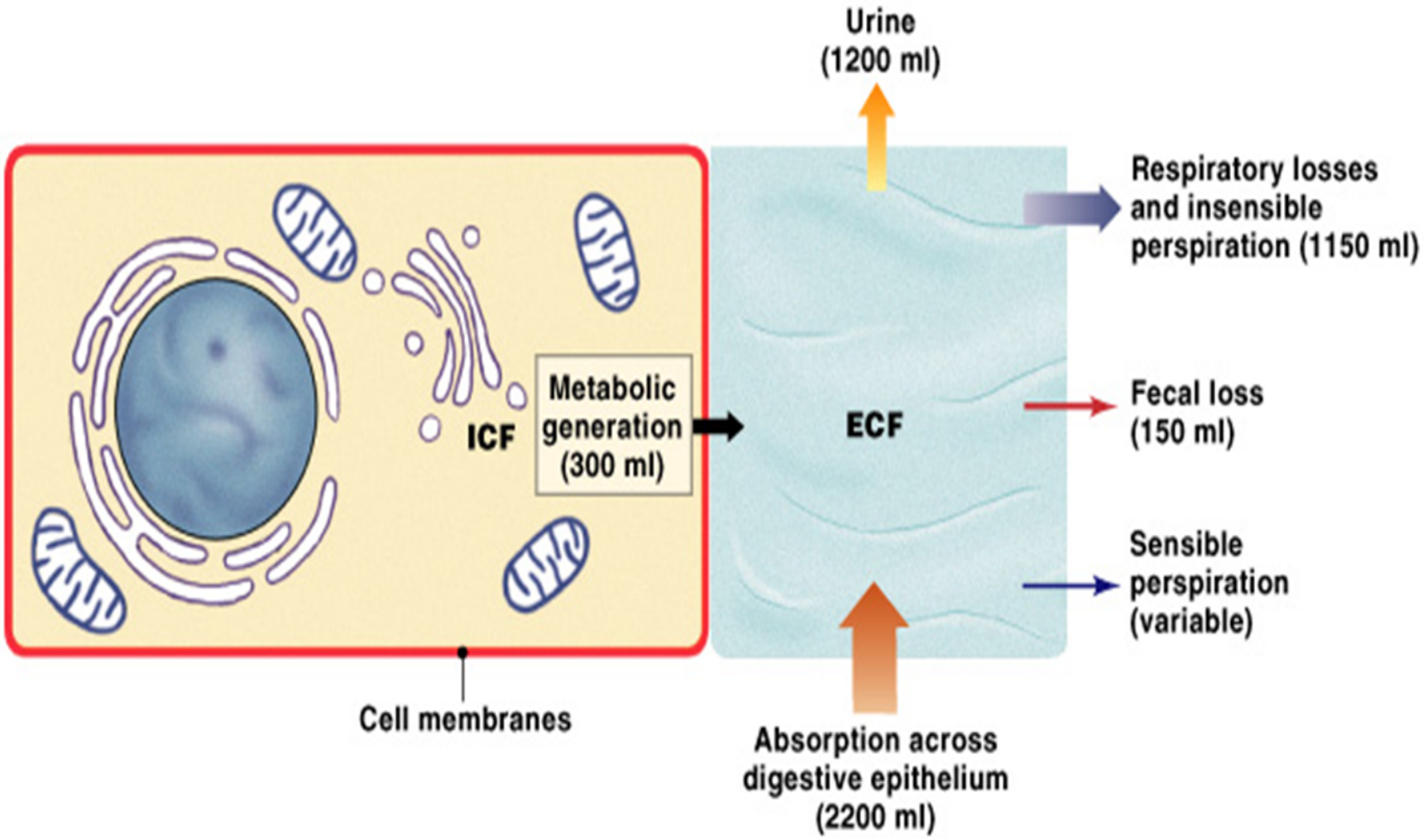




Systemic Routes of Gains and Losses

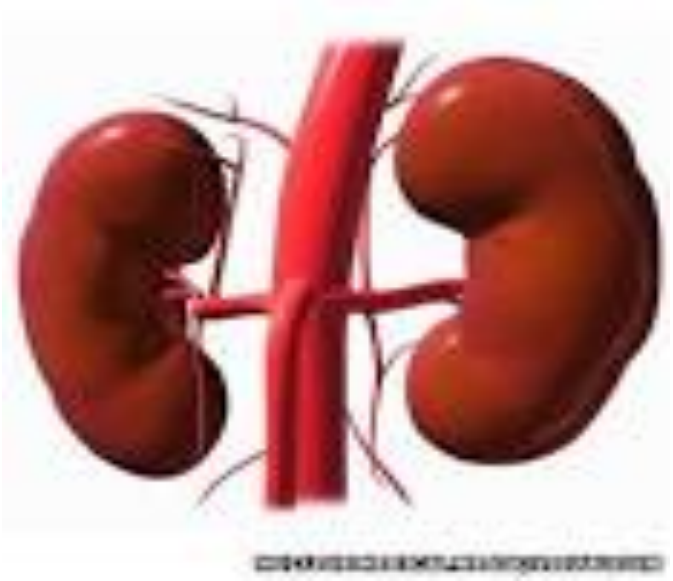
- Water and electrolytes are gained in various ways. Healthy people gain fluids by drinking and eating, and their daily average intake and output of water are approximately equal. **Organs of fluid loss**: kidneys, skin, lungs, and GI tract.

Fluid Gains and Losses



Kidneys

The usual daily urine volume in adult is 1 to 2 L. A general rule is that the output is approximately 1 mL of urine per kilogram of body weight per hour (1 mL/kg/h) in all age groups.



Skin

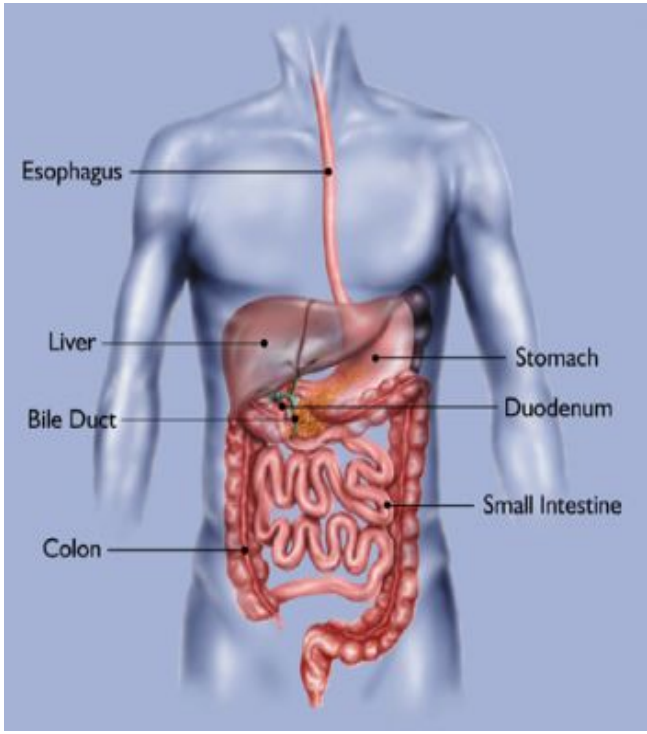
- Sensible perspiration refers to visible water and electrolyte loss through the skin (sweating). Actual sweat losses can vary from 0 to 1000 mL or more every hour, Continuous water loss by evaporation (approximately 600 mL/day) occurs through skin as insensible perspiration.

Lungs

- Lungs normally eliminate water vapor (insensible loss) at a rate of approximately 300 mL every day. hyperpnea (abnormal deep respiration) or continuous coughing, increase this loss; mechanical ventilation with excessive moisture decreases it.

Gastrointestinal Tract

- Usual loss through GI tract is 100 to 200 mL daily, even though nearly 8 L of fluid circulates through GI system every 24 hours. Because bulk of fluid is normally reabsorbed in small intestine, diarrhea and fistulas cause large losses.

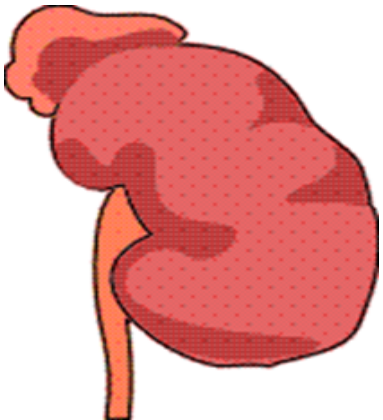


Homeostatic Mechanisms

- The body is equipped with homeostatic mechanisms to keep composition and volume of body fluids within limits of normal.

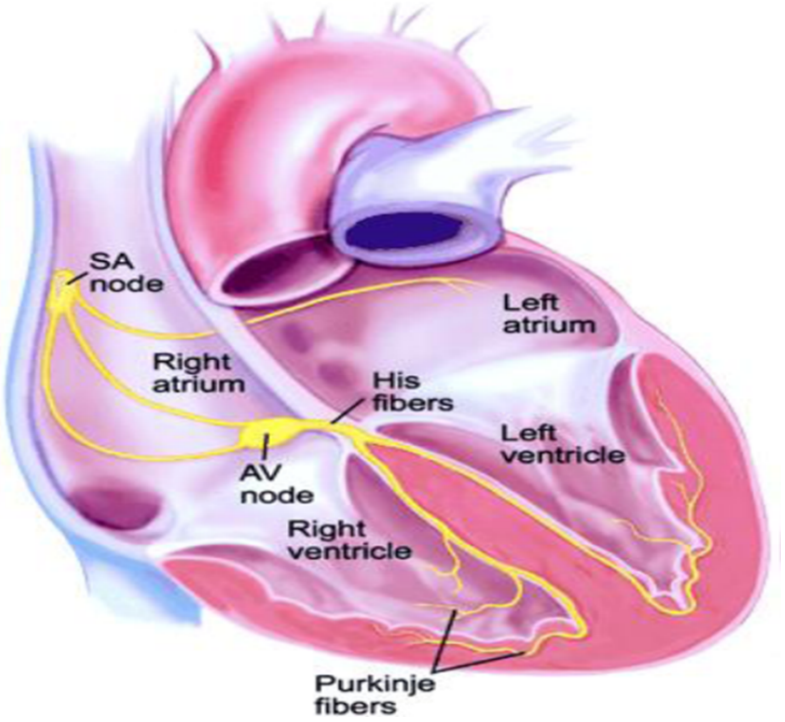
Kidney Functions

- kidneys normally filter 180 L of plasma every day in the adult and excrete 1 to 2 L of urine. They act both autonomously and in response to blood borne messengers, such as aldosterone and antidiuretic hormone (ADH).



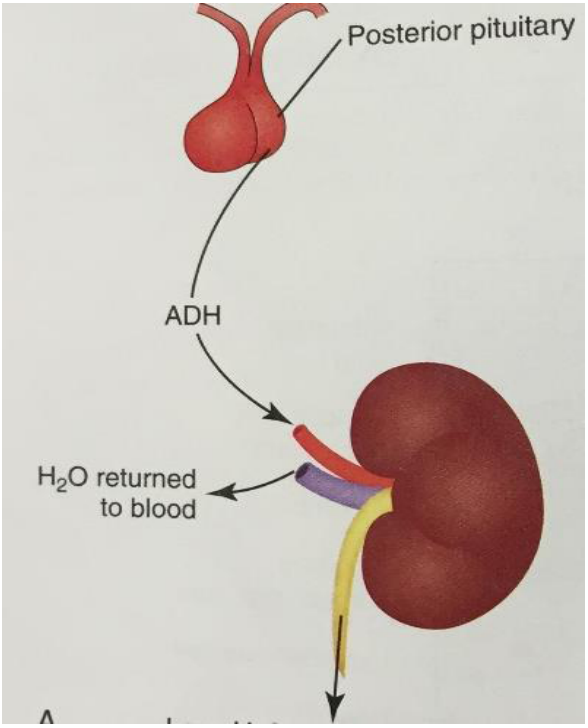
Heart and Blood Vessel Functions

- Pumping action of the heart circulates blood through kidneys under sufficient pressure to allow for urine formation.
- Failure of this pumping action interferes with renal perfusion and with water and electrolyte regulation.



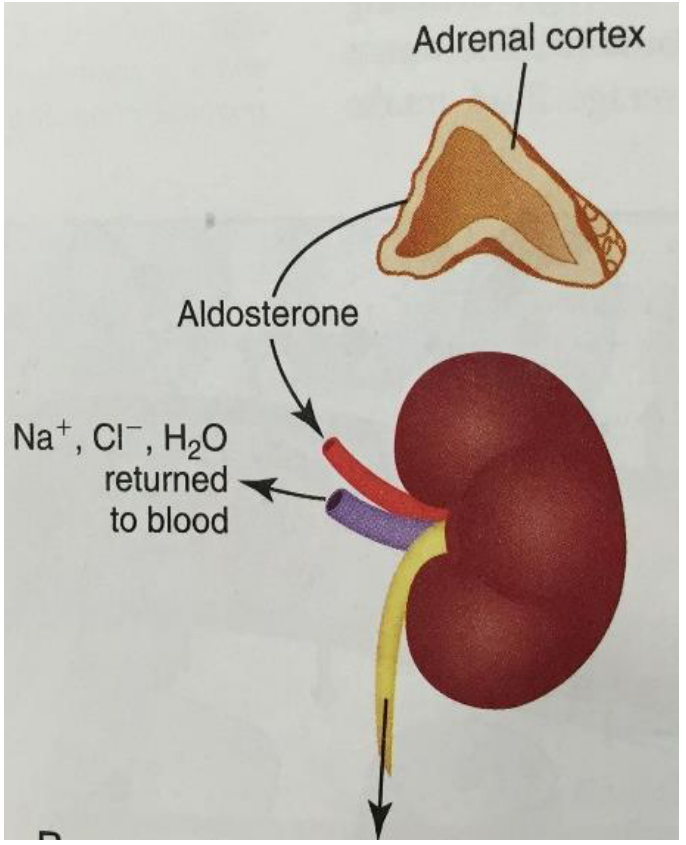
Pituitary Functions

- Hypothalamus manufactures ADH, which is stored in posterior pituitary gland and released as needed. ADH control the retention or excretion of water by the kidneys and regulate blood volume.



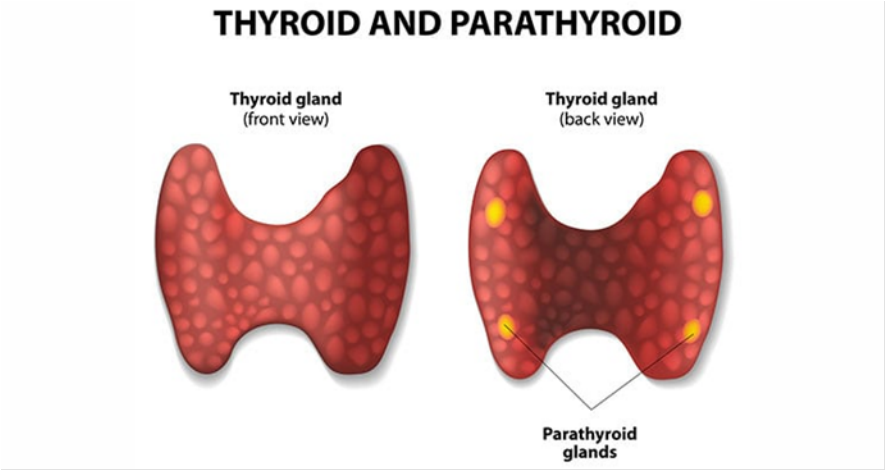
Adrenal Functions

- Aldosterone, a hormone secreted by outer zone of adrenal cortex, has a profound effect on fluid balance. Increased secretion of aldosterone causes sodium retention, water retention and potassium loss.



Parathyroid Functions

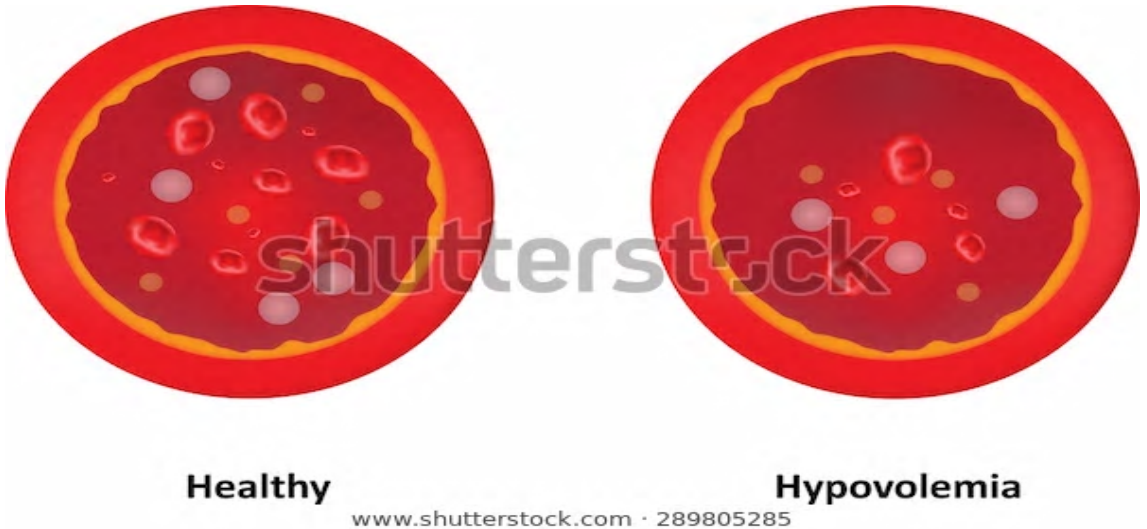
- Parathyroid glands, embedded in thyroid gland, regulate calcium and phosphate balance by parathyroid hormone. PTH influences calcium absorption from intestines, and calcium reabsorption from renal tubules.



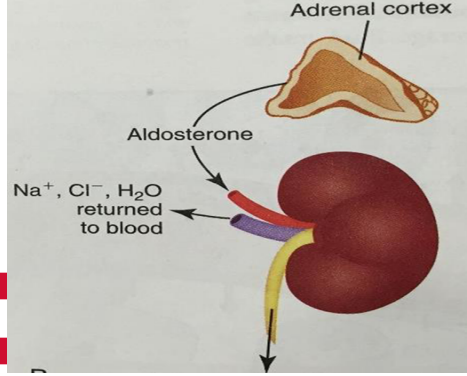
FLUID VOLUME DISTURBANCES

Hypovolemia

- Fluid volume deficit (FVD), or hypovolemia, occurs when loss of ECF volume exceeds the intake of fluid.



Pathophysiology



1. Abnormal fluid losses, such as vomiting, diarrhea, GI suctioning, hemorrhage and sweating.
2. Decreased intake, nausea or lack of access to fluids (coma).
3. movement of fluid from vascular system to other body spaces (eg, edema formation in burns, ascites with liver dysfunction).
4. Additional causes: diabetes insipidus, adrenal insufficiency.

Clinical Manifestations

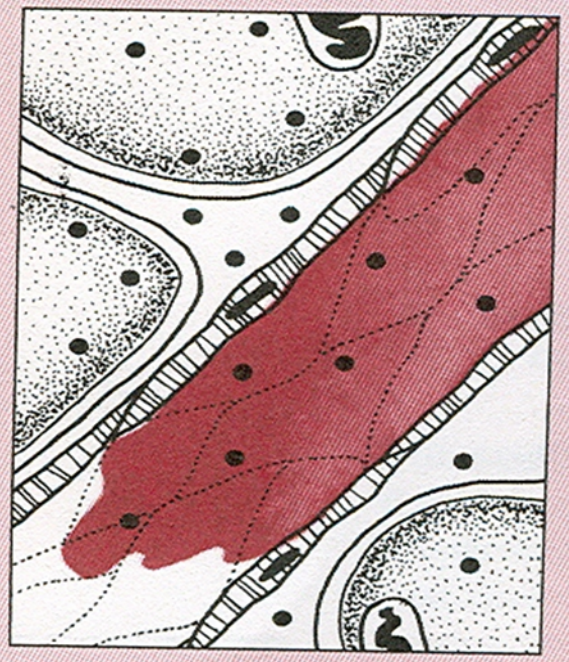
1. Acute weight loss.
2. A weak, rapid heart rate.
3. Orthostatic hypotension due to volume depletion. (decrease systolic pressure exceeding 15 mmHg when patient moves from lying to sitting position).
4. Increased temperature.
5. Decreased central venous pressure.

6. Oliguria; and concentrated urine.
7. Decreased skin turgor.
8. Cool, clammy, pale skin related to peripheral vasoconstriction.
9. Flattened neck veins.
10. thirst; decreased or delayed capillary refill.
11. Anorexia; nausea; lassitude; muscle weakness; and cramps.

Understanding I.V. solutions

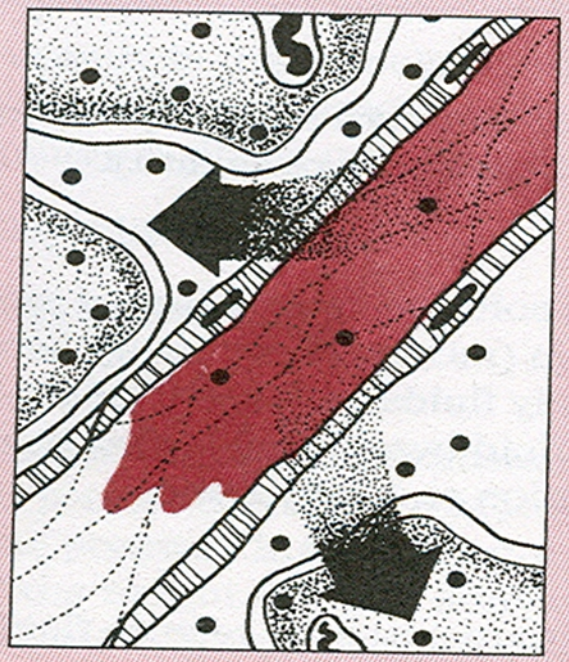
Solutions used for I.V. therapy may be isotonic, hypotonic, or hypertonic. The type you give a patient depends on whether you want to change or maintain his body fluid status.

Isotonic solution



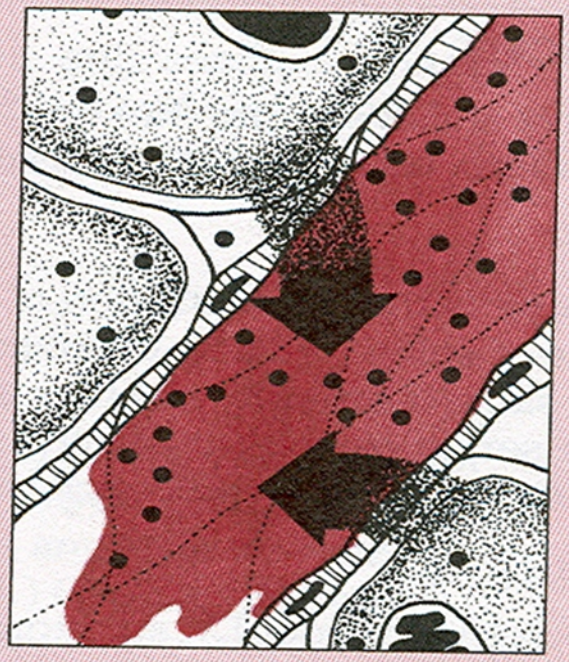
An isotonic solution has an osmolarity about equal to that of serum. Because it stays in the intravascular space, it expands the intravascular compartment.

Hypotonic solution



A hypotonic solution has an osmolarity lower than that of serum. It shifts fluid out of the intravascular compartment, hydrating the cells and the interstitial compartments.

Hypertonic solution

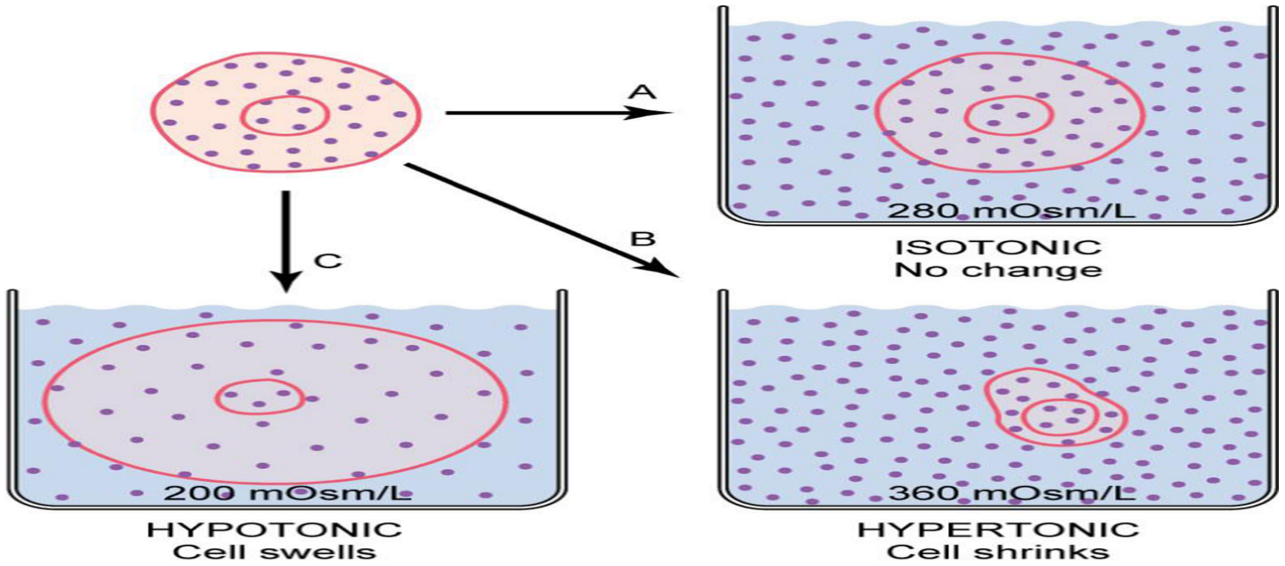


A hypertonic solution has an osmolarity higher than that of serum. It draws fluid into the intravascular compartment from the cells and the interstitial compartments.

Medical Management

- If the deficit is not severe, oral route is preferred, provided the patient can drink.
- If fluid losses are acute or severe, IV route is required. Isotonic electrolyte solutions (eg, lactated Ringer's solution, 0.9% sodium chloride) are used to treat hypotensive patient with FVD because they expand plasma volume.

- As patient becomes normotensive, a hypotonic electrolyte solution (eg, 0.45% sodium chloride) is used to provide both electrolytes and water for renal excretion of metabolic wastes.



From Hall JE: *Guyton and Hall textbook of medical physiology*, ed 12, Philadelphia, 2011, Saunders.

Nursing Management

✓ Nurse monitors and measures fluid I&O at least every 8 hours, and sometimes hourly.

✓ Daily body weights are monitored; loss of 0.5 kg represents a fluid loss of approximately 500 mL.

✓ Monitor vital signs.

✓Accurate assessments of central venous pressure, and, breath sounds to avoid volume overload.

✓ Skin and tongue turgor are monitored.

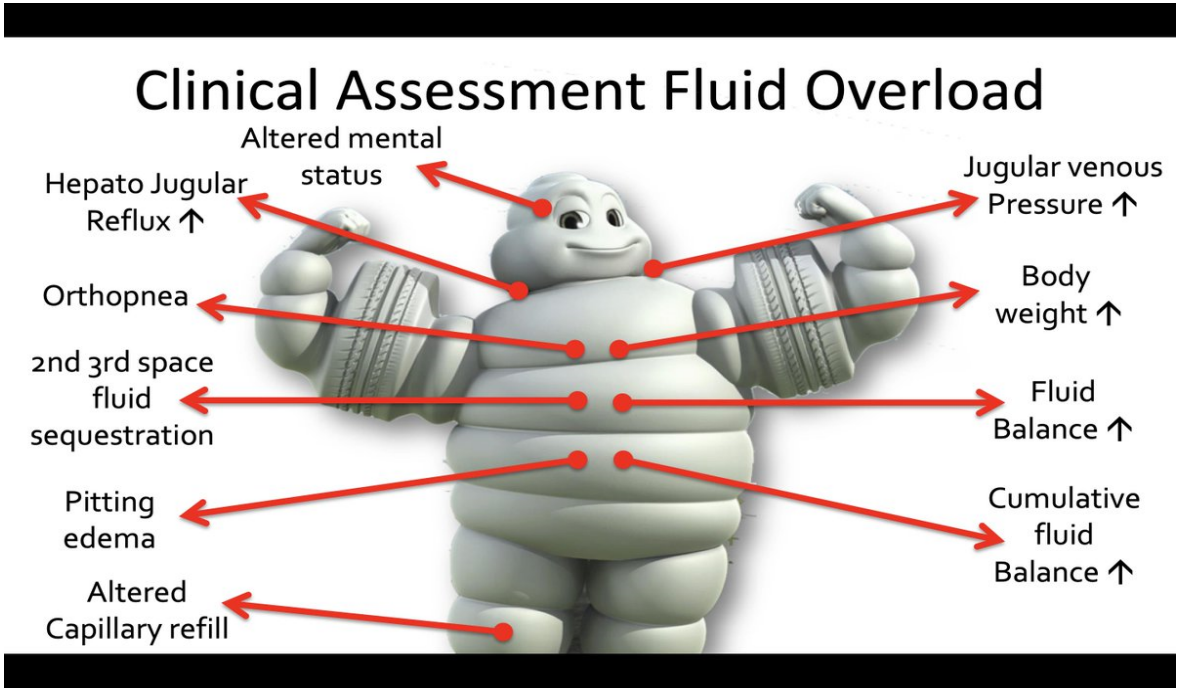
✓ Urine concentration is monitored (Normal urine specific gravity 1.010 to 1.025)

✓ Assess level of consciousness (Mental function is affected in severe FVD as a result of decreasing cerebral perfusion).

✓ Decreased peripheral perfusion cause cold extremities.

Hypervolemia

Fluid volume excess (FVE), or hypervolemia, refers to an isotonic expansion of the ECF caused by the abnormal retention of water and sodium.



Pathophysiology

✓ Heart failure, renal failure, and cirrhosis of the liver.

✓ Consumption of excessive amounts of table or other sodium salts.

✓ Excessive administration of sodium-containing fluids in a patient with impaired regulatory mechanisms.

Clinical Manifestations

✓ Increased weight

✓ Tachycardia; increased blood pressure, pulse pressure, and central venous pressure;

✓ Edema, and distended neck veins.

✓ Increased urine output.

✓ crackles (abnormal lung sounds).

✓Shortness of breath and wheezing.

Medical Management

✓ Management of FVE is directed at the causes.

✓ If related to excessive administration of sodium-containing fluids, discontinue the infusion.

✓ Symptomatic treatment consists of administering diuretics and restricting fluids and sodium.

Nursing Management

✓ Nurse measures I &O at regular intervals to identify excessive fluid retention.

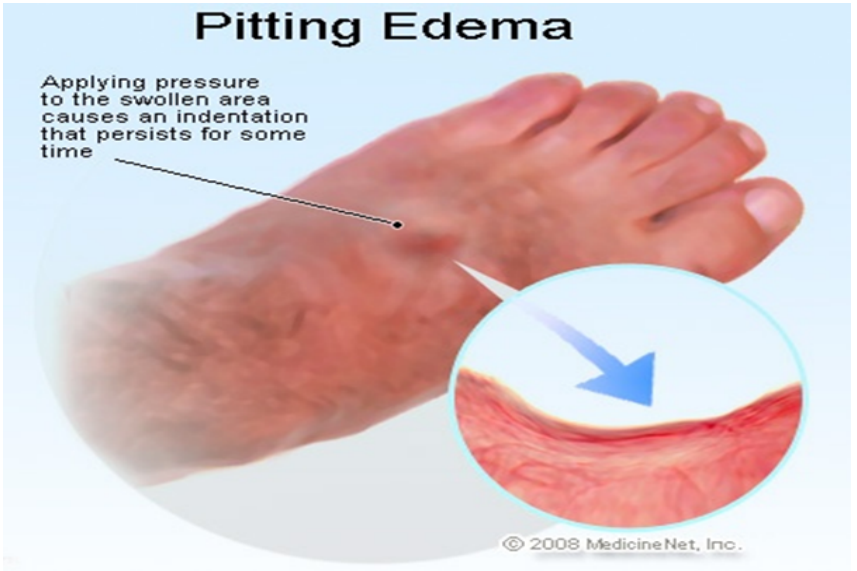
✓ Patient is weighed daily, and rapid weight gain

✓ Breath sounds are assessed at regular intervals.

✓ Nurse monitors degree of edema in the most dependent parts of body, such as feet and ankles in ambulatory patients and sacral region in patients confined to bed.

✓ Pitting edema is assessed by pressing a finger into affected part, creating a pit or indentation that is evaluated on a scale of 1_ (minimal) to 4_ (severe).

✓ Peripheral edema is monitored by measuring circumference of extremity.



ELECTROLYTE IMBALANCES

Disturbances in electrolyte balances are common in clinical practice and must be corrected.

Sodium Imbalances

Sodium is the most plentiful electrolyte in the ECF; its concentration ranges from 135 to 145 mEq/L and it is the primary determinant of ECF volume.

Functions of sodium:

Sodium has a major role in controlling water distribution throughout the body, because it does not easily cross the cell wall membrane.

Sodium functions in establishing the electrochemical state necessary for muscle contraction and transmission of nerve impulses.

SODIUM DEFICIT (HYPONATREMIA)

A serum sodium level is less than 135 mEq/L .

Pathophysiology

Fluid loss (vomiting, & diarrhea).

A deficiency of aldosterone, as in adrenal insufficiency, predisposes to sodium deficiency.

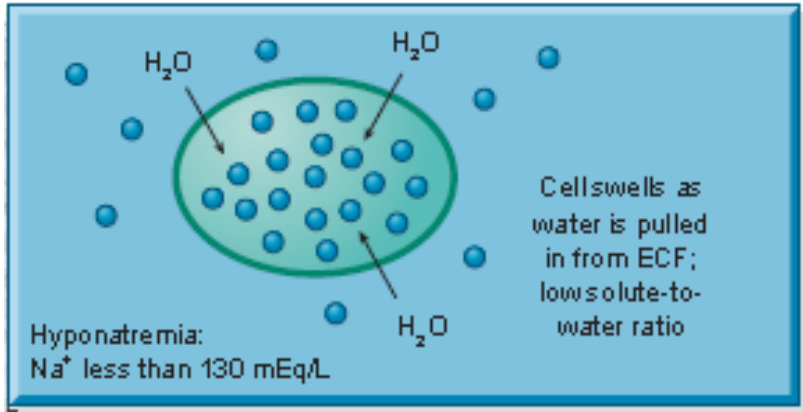
use of certain medications, such as anticonvulsants (Tegretol), increases risk of hyponatremia.

Clinical Manifestations

Poor skin turgor, dry mucosa, headache, decreased saliva production, orthostatic fall in blood pressure.

Nausea, vomiting, and abdominal cramping.

Neurologic changes: altered mental status, status epilepticus, and coma, are probably related to cellular swelling and cerebral edema.



Medical Management

Sodium Replacement:

The most common treatment for hyponatremia is careful administration of sodium by mouth, nasogastric tube, or a parenteral route.

For those who cannot consume sodium, lactated Ringer's solution or isotonic saline (0.9% sodium chloride) solution may be prescribed.

Nursing Management

Monitors fluid I &O as well as daily body weight.

Nurse monitors for CNS changes, such as lethargy, confusion, muscle twitching, and seizures.

Serum sodium is monitored; when indicated, urine sodium and specific gravity are monitored.

Nurse encourages foods and fluids with high sodium. (8 oz of tomato juice contains 700 mg of sodium).

SODIUM EXCESS (HYPERNATREMIA)

Hypernatremia is a serum sodium level higher than 145 mEq/L.

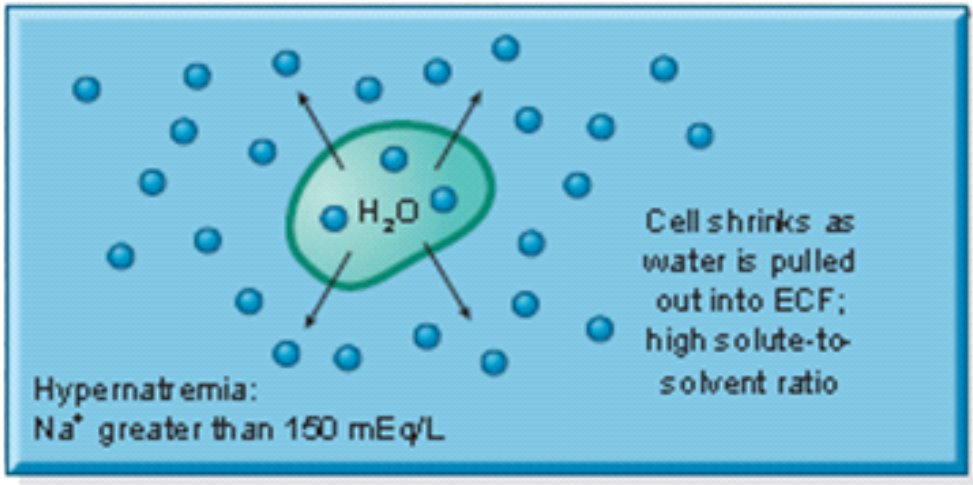
Pathophysiology

Fluid deprivations in unconscious patients who cannot perceive, respond to their thirst.

Administration of hypertonic enteral feedings without adequate water supplements.

Watery diarrhea and greatly increased insensible water loss (hyperventilation, burns).

Less common causes: near drowning in sea water (sodium concentration of nearly 500 mEq/L).



Hypernatremia Signs and "FRIED SALT" Symptoms

F Flushed skin and fever (low-grade)
R Restless, irritable, anxious, confused
I Increased blood pressure and fluid retention
E Edema: peripheral and pitting
D Decreased urine output and dry mouth

S Skin flushed
A Agitation
L Low-grade fever
T Thirst

Medical Management:

Gradual lowering of serum sodium level by infusion of a hypotonic electrolyte solution (eg, 0.3% sodium chloride) or an isotonic non saline solution (eg, dextrose 5% in water [D5W]).

Nursing Management

Fluid losses and gains are carefully monitored.

Nurse should assess for abnormal losses of water or low water intake and for large gains of sodium.

Nurse monitors for changes in behavior, such as restlessness, disorientation, and lethargy.

with decreased level of consciousness, parenteral fluid replacement may be prescribed.

Potassium Imbalances

- Potassium is the major intracellular electrolyte; 98% of the body's potassium is inside the cells. The remaining 2% is in the ECF and is important in neuromuscular function. The normal serum potassium level 3.5 to 5.0 mEq/L

Functions of potassium

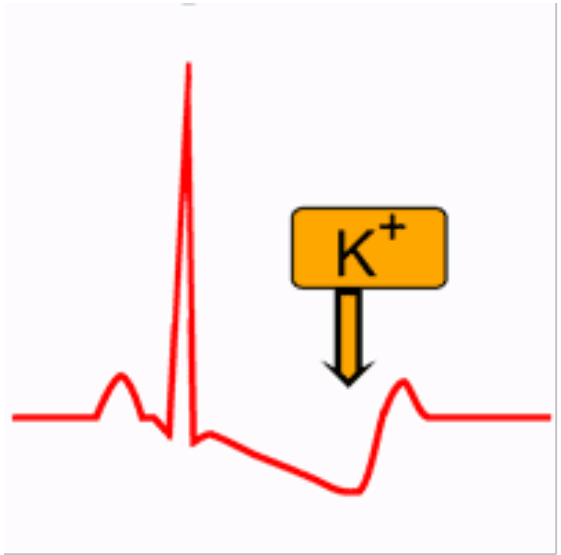
- Potassium influences both skeletal and cardiac muscle activity. EX: alterations in its concentration change myocardial irritability and rhythm.

POTASSIUM DEFICIT (HYPOKALEMIA)

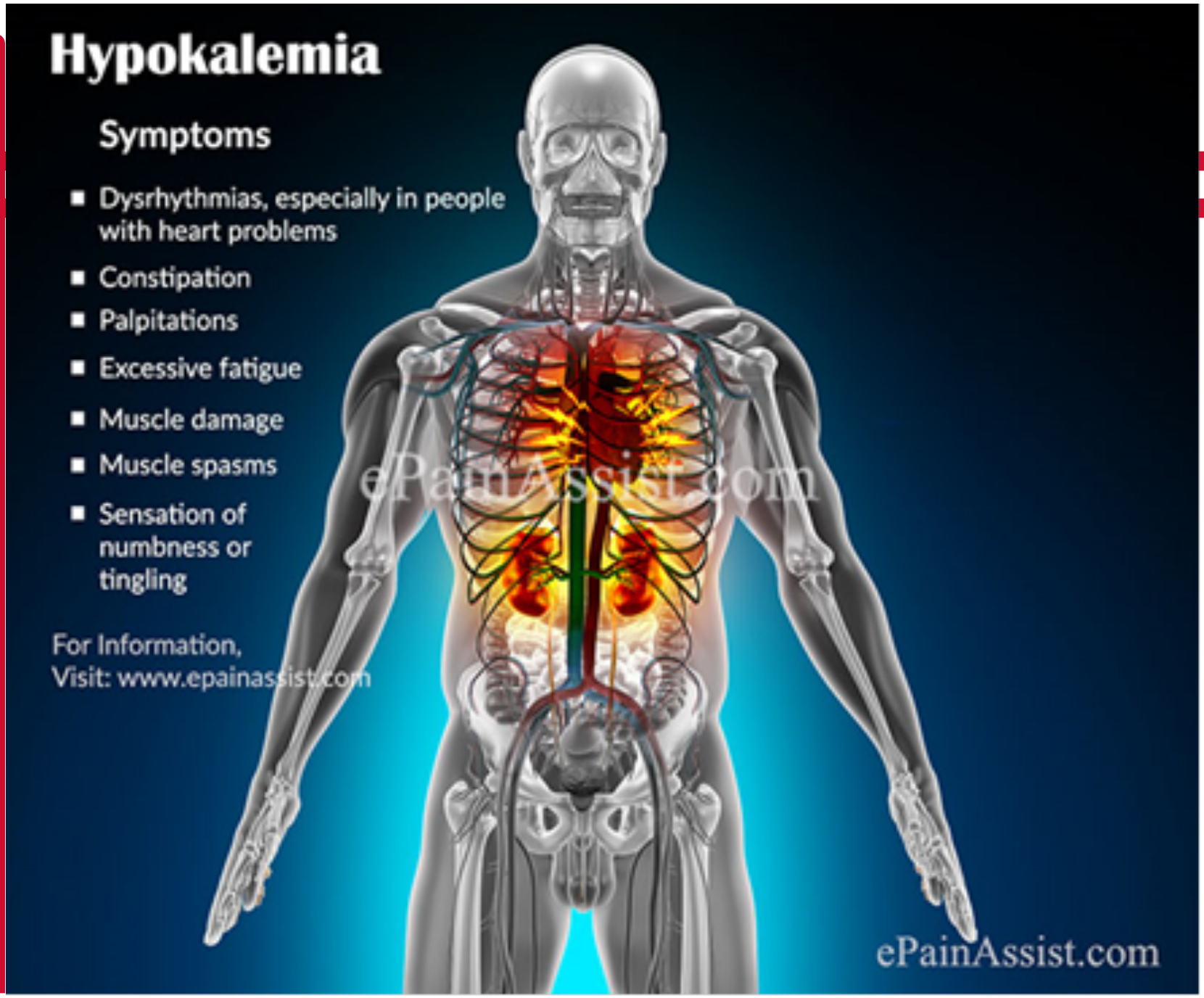
- Hypokalemia (below 3.5 mEq/L [3.5 mmol/L]) usually indicates a deficit in total potassium stores.

Pathophysiology

- Potassium-losing diuretics, such as thiazides.
- GI loss of potassium (Vomiting and gastric suction) because potassium is lost when gastric fluid is lost.



- Prolonged intestinal suctioning, recent ileostomy, & villous adenoma (tumor of intestine characterized by excretion of potassium-rich mucus).
- Patients who do not eat a normal diet for a prolonged period (debilitated elderly people, alcoholism, or anorexia nervosa).


Hypokalemia
Symptoms
Dysrhythmias, especially in people with heart problems
Constipation
Palpitations
Excessive fatigue
Muscle damage
Muscle spasms
Sensation of numbness or tingling
For Information, Visit: www.epainassist.com
ePainAssist.com
ePainAssist.com

Clinical Manifestations

- Fatigue, anorexia, nausea, vomiting, muscle weakness, leg cramps, decreased bowel motility, paresthesias (numbness), and dysrhythmias.
- Severe hypokalemia can cause death through cardiac or respiratory arrest.

Medical Management

- Dietary intake of potassium in adult is 50 to 100 mEq/day. Foods high in potassium include fruit juices and bananas, melon, citrus fruits, fresh and frozen vegetables, fresh meats, and milk.

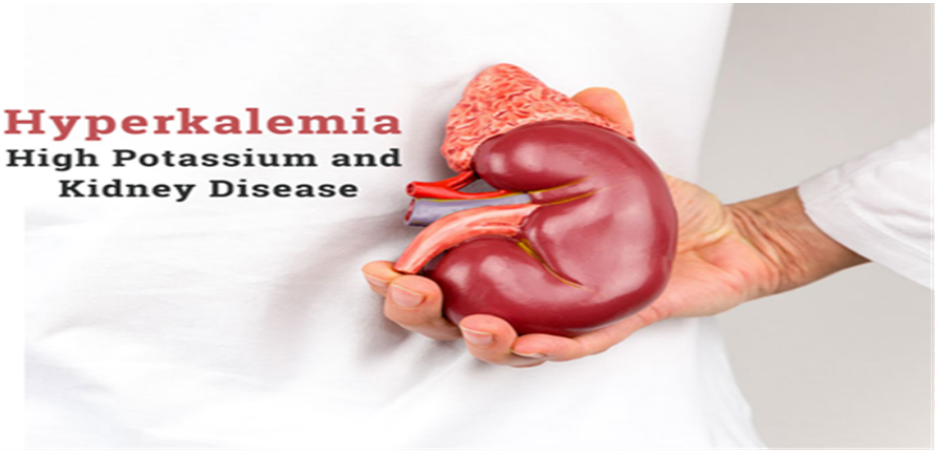
- If hypokalemia cannot be prevented by increased intake in daily diet or by oral potassium supplements, it is treated with IV replacement therapy.
- Potassium chloride is usually used to correct potassium deficits.

Nursing Management

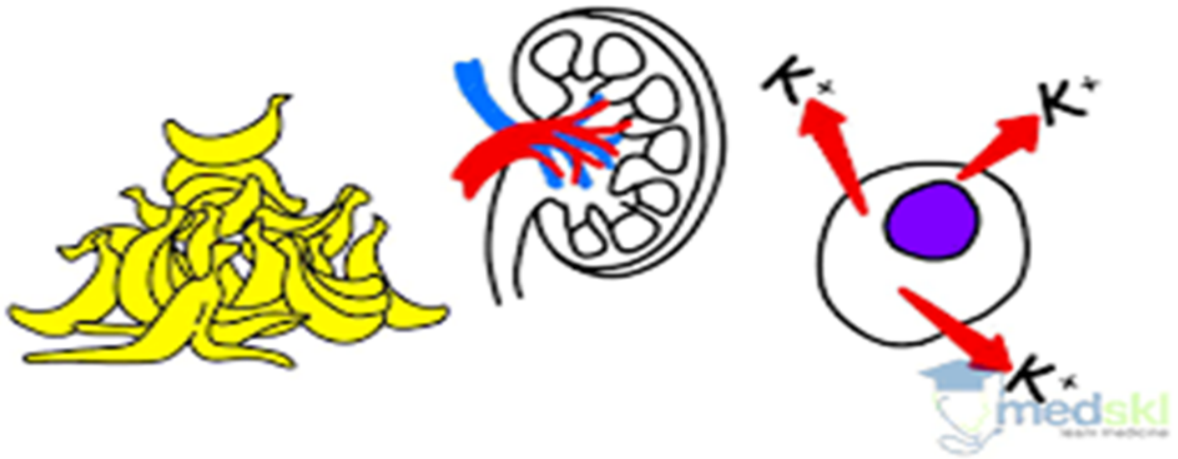
- Nurse monitor for fatigue, anorexia, muscle weakness, decreased bowel motility, paresthesias, and dysrhythmias.
- Careful monitoring of fluid I& O , because 40 mEq of potassium is lost for every liter of urine output.
- ECG is monitored for changes.
- Renal function should be monitored through BUN and creatinine levels and urine output.

POTASSIUM EXCESS (HYPERKALEMIA)

- Hyperkalemia (greater than 5.0 mEq/L) seldom occurs in patients with normal renal function.
- Although it is less common than hypokalemia, it is more dangerous, because cardiac arrest is more frequently associated with high serum potassium levels.



Causes



- Decreased renal excretion of potassium (CRF).
- Rapid administration of potassium.
- Excessive intake of potassium food or medications.
- Medications as (potassium chloride, heparin, and potassium sparing diuretics).

Clinical Manifestations

- GI manifestations: nausea, intermittent intestinal colic, and diarrhea.
- When level is 8 mEq/L or greater, disturbances in cardiac conduction occur.
- Ventricular dysrhythmias and cardiac arrest.
- Severe hyperkalemia causes skeletal muscle weakness and even paralysis.
- Respiratory and speech muscles paralysis can occur.

Medical Management

- ECG is obtained immediately to detect changes.
- In non acute situations, restriction of dietary potassium and potassium-containing medications.
- IV administration of hypertonic dextrose solution causes a temporary shift of potassium into the cells.

Nursing Management

- Nurse observes signs of muscle weakness and dysrhythmias.
- Serum potassium levels, as well as BUN, creatinine.
- Administer & monitor potassium solutions carefully
- Encourage foods with minimal potassium content include butter, cranberry juice or sauce, gumdrops or jellybeans, hard candy, sugar, and honey.


Thank you