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Nakhon Pathom Rajabhat University

Nursing Care of Patients with Acid-Base Imbalance



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Learning Objectives:

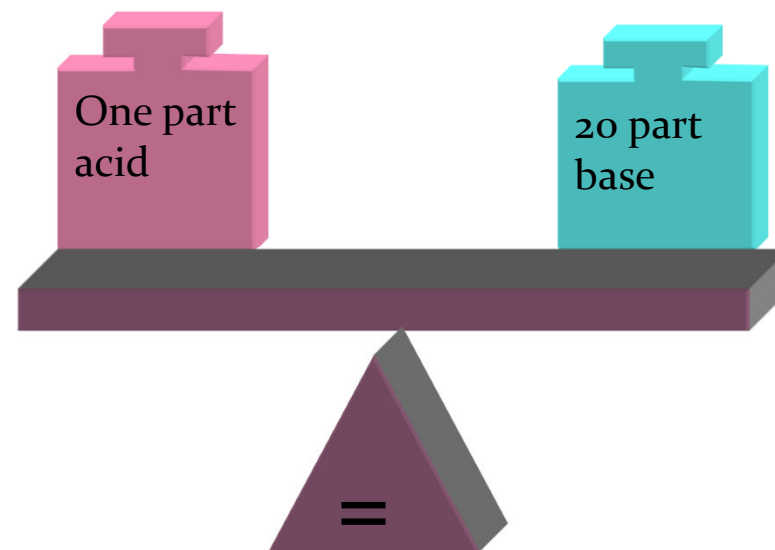
At the end of this lecture, all students will be able to:

- Define pH, acid, and base.
- Discuss how the body regulates acid-base balance.
- Identify the main diagnostic tests used to assess acid-base imbalance.
- Identify ABG parameters.
- Differentiate between the respiratory and metabolic imbalances regarding their causes, and clinical manifestations.



Acid base balance :

- Equilibrium between the acid and base elements of the blood and body fluids.

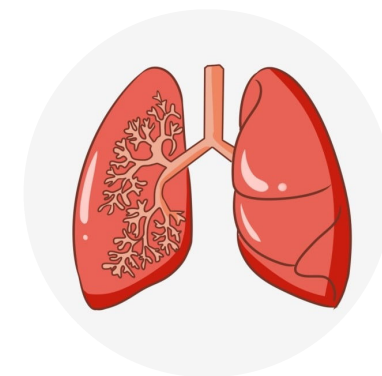




Regulation of acid-base balance

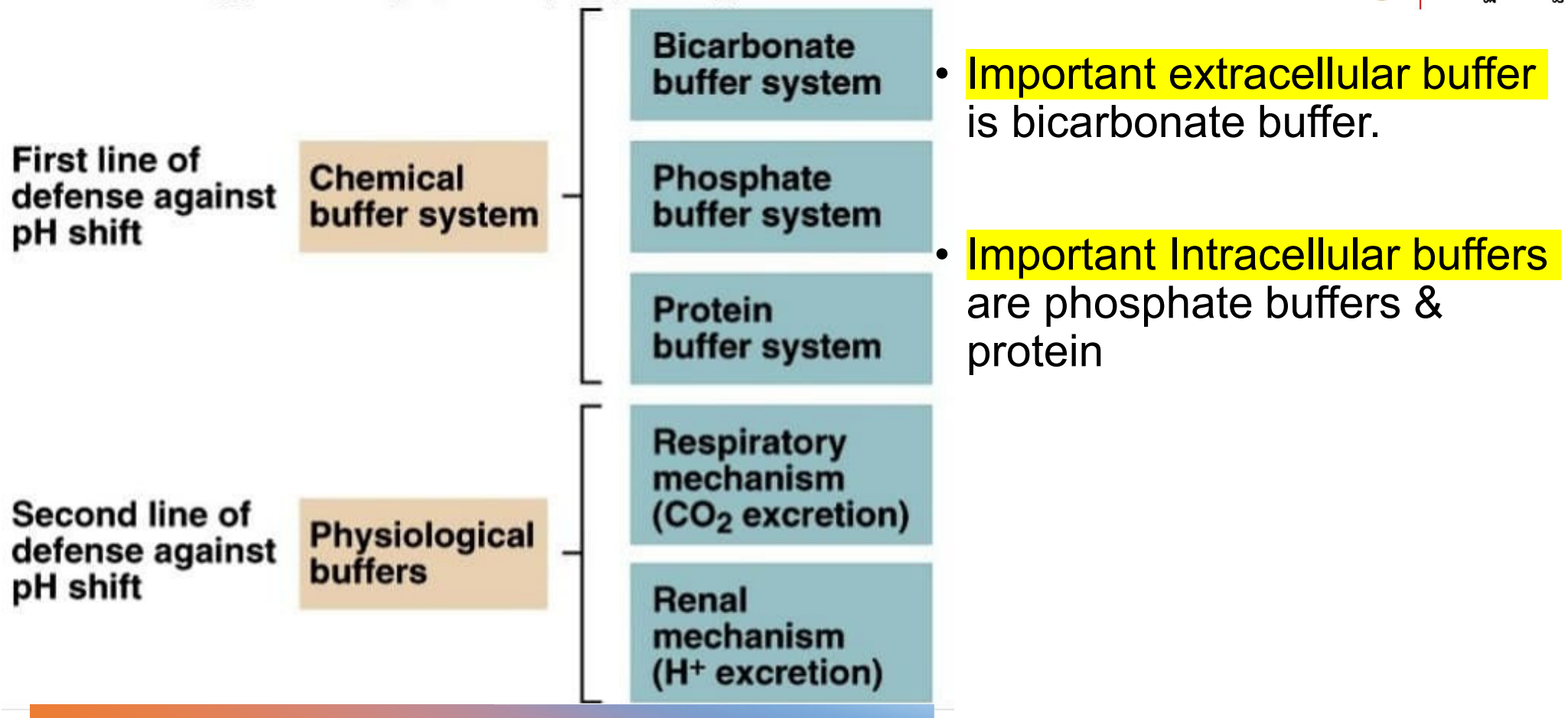
The body has three mechanisms to maintain acid-base balance:

- 1- Buffering mechanism.
- 2- The respiratory compensation mechanism.
- 3- The metabolic or renal compensation mechanism.





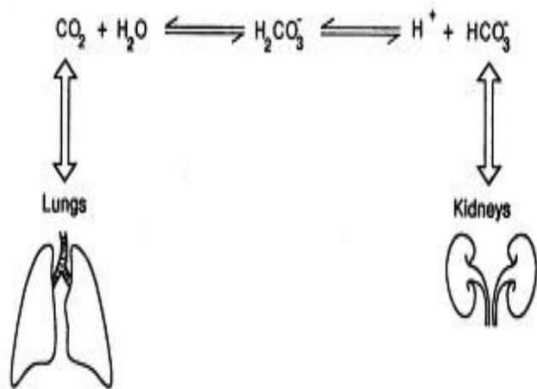
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Respiratory regulation of acid-base balance

- Chemo receptors in the medulla of the brain sense the pH changes and vary the rate and depth of breathing to compensate.
- When pH decreases: Breathing faster or deeper (Hyperventilation) Eliminate more CO₂ leading to increased pH



- When pH increases: Slow and shallow breathing (Hypoventilation) Leads to accumulation of CO₂ and decreased pH



Renal regulation of acid-base balance

Kidneys make long- term adjustment to pH.

- They reabsorb acids and bases or excrete them into urine, and can also produce HCO_3^- to replenish lost supply.
- If the blood contains too much acids or not enough base, the pH drops and the kidneys in response reabsorb NaHCO_3 and excrete (H^+) leading to normalization of pH.

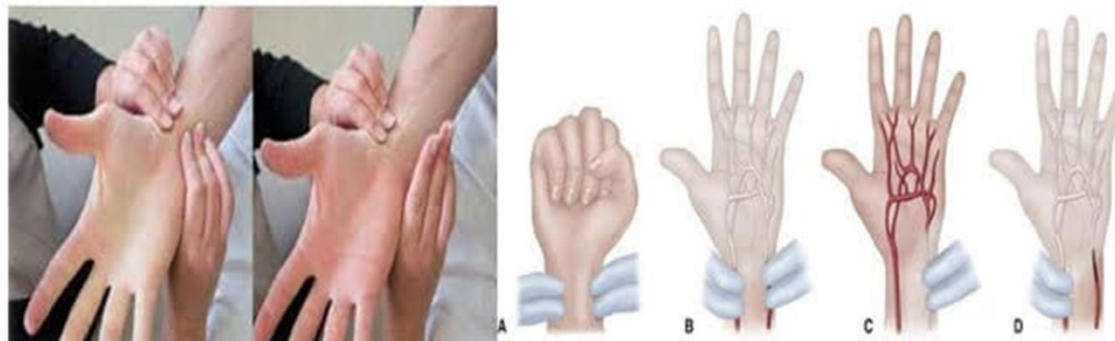


Diagnosis of acid base imbalance:

- 1-Arterial Blood Gases (ABG).
- 2-Anion gap estimation.

Allen's Test And its procedure

mcqs nursing@gmail.com





ABG parameters:

- pH [H^+]
- PCO_2 Partial pressure CO_2
- PO_2 Partial pressure O_2
- HCO_3 Bicarbonate
- BE Base excess
- SaO_2 Oxygen Saturation

Normal values:



Parameters	Normal values
pH	7.35-7.45
PaCO ₂	35-45
HCO ₃	22-26
PaO ₂	80-100
SaO ₂	%More than 95
B/E	(+/-) 2



Arterial Blood Gases Interpretation:

Step 1: Classify the pH

Step 2: Assess PaCO₂

Step 3: Assess HCO₃

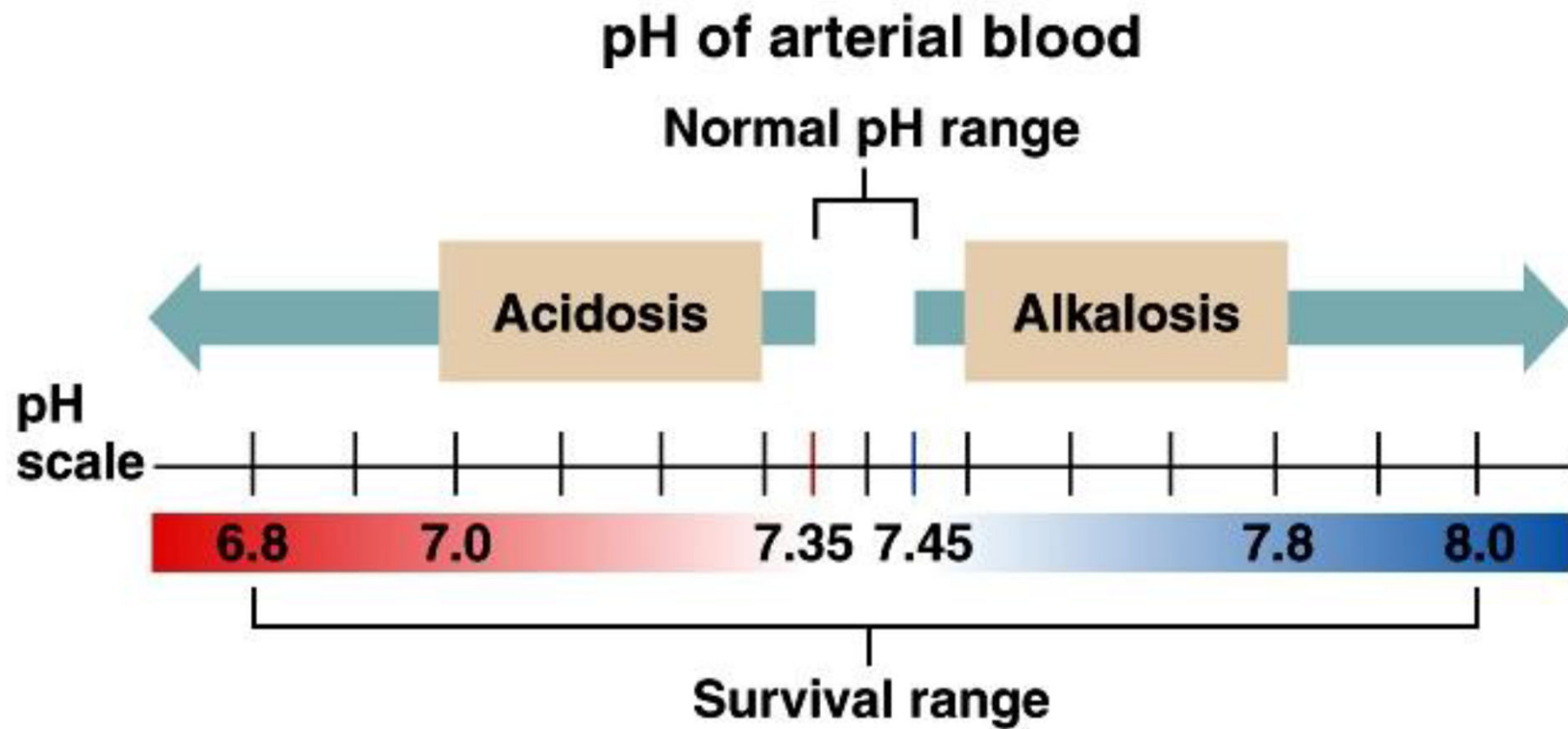
Step 4: Determine the presence of compensation:

- Total compensation
- Partial compensation
- Uncompensation

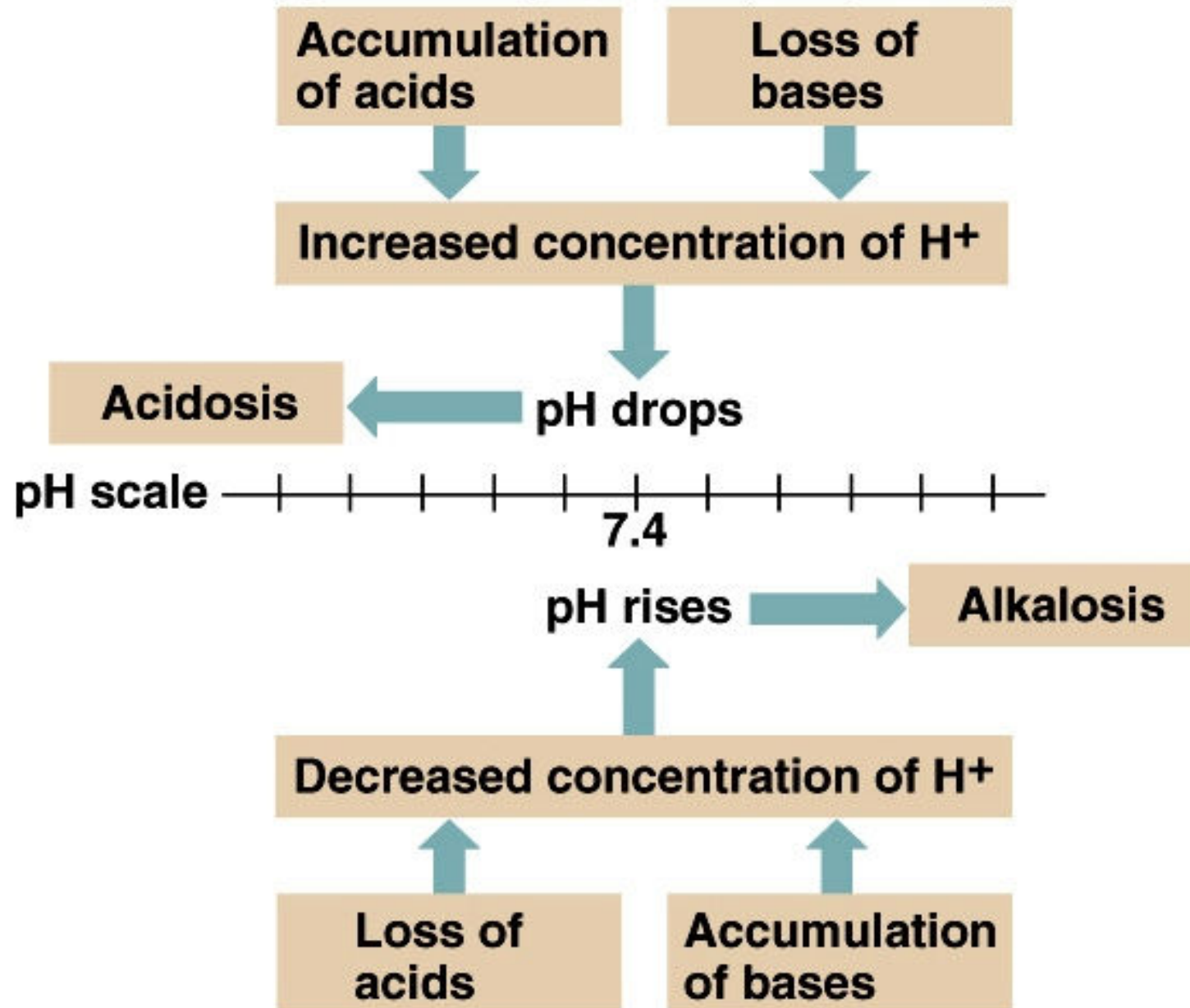


Acid - base imbalance





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Acid –base imbalance:

ABG	pH	PaCO ₂	HCO ₃
Respiratory Acidosis	↓	↑	normal
Respiratory Alkalosis	↑	↓	normal
Metabolic Acidosis	↓	normal	↓
Metabolic Alkalosis	↑	normal	↑

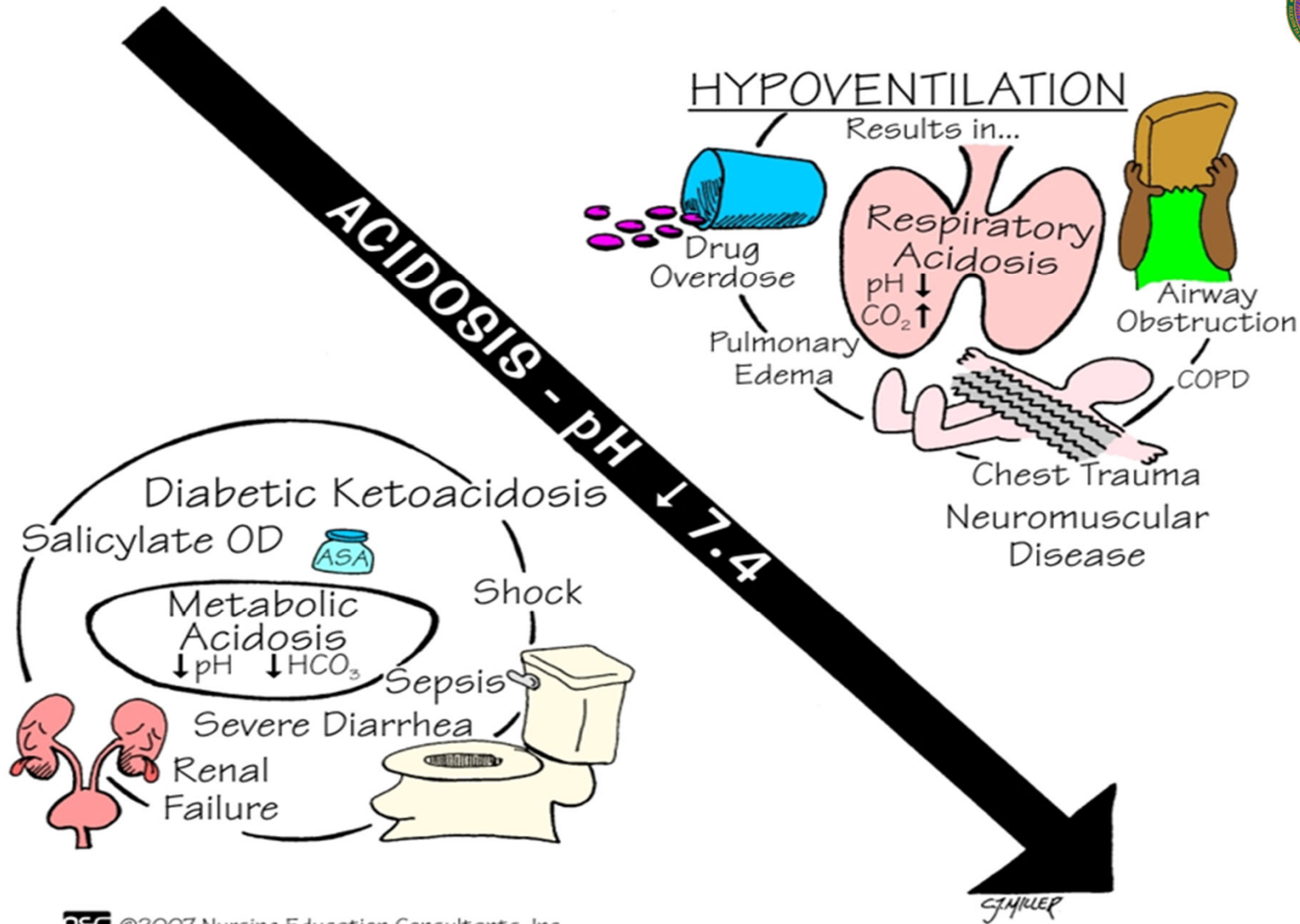
- Respiratory acidosis.
- Respiratory alkalosis.
- Metabolic acidosis.
- Metabolic alkalosis.

ACID BASE MNEMONIC (ROME)

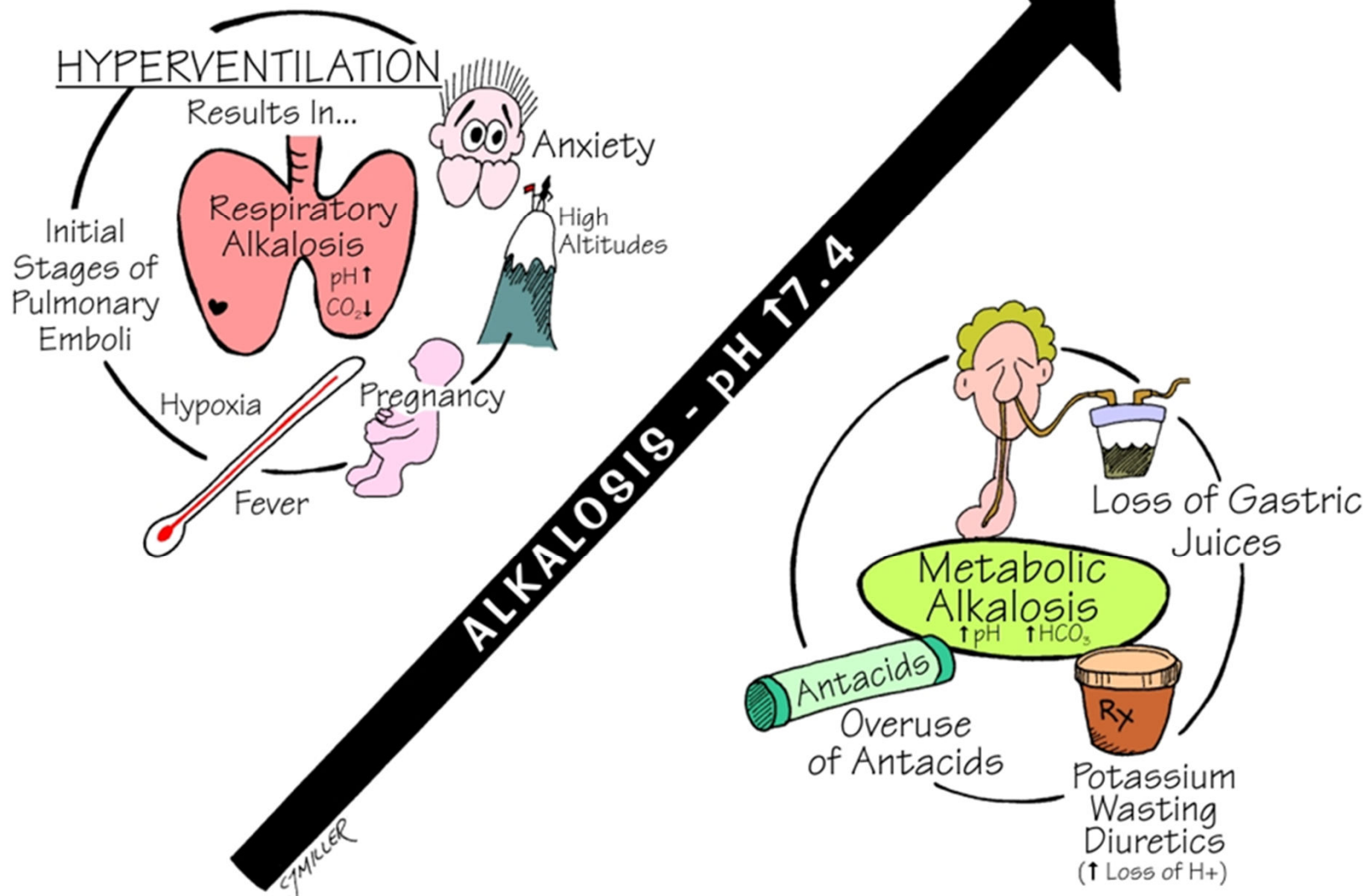


R	R espiratory
	O pposite
O	pH \uparrow PCO_2 \downarrow Alkalosis
	pH \downarrow PCO_2 \uparrow Acidosis
M	M etabolic
	E qual
E	pH \uparrow HCO_3 \uparrow Alkalosis
	pH \downarrow HCO_3 \downarrow Acidosis

CAUSES OF ACIDOSIS



CAUSES OF ALKALOSIS



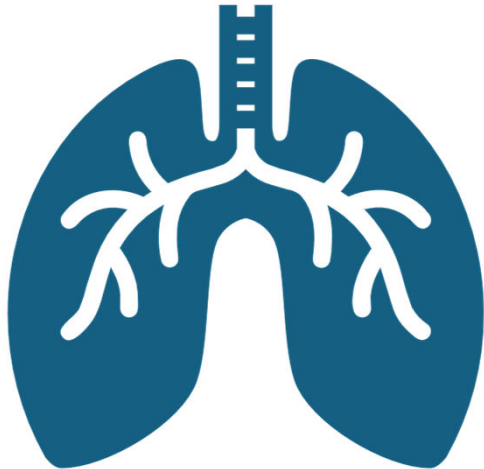


Lungs

- 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 CO_2 and pH rises
- Slower rate/less depth = retain CO_2 and pH lowers



Respiratory Acidosis



- It occurs with any mechanism that decreases the rate of alveolar ventilation.
- **It is characterized by:**
 - pH < 7.35
 - PaCO₂ > 45 mmHg
 - compensatory increase in HCO₃⁻



Causes of respiratory acidosis:

❑ Depression of respiratory center:

- Narcotics / over sedation.
- Anesthesia.

❑ Respiratory arrest.

- Paralysis of respiratory muscles eg; Myasthenia gravis, GB Syndrome, etc.
- Impaired ventilation
- Airway obstruction: Foreign body.

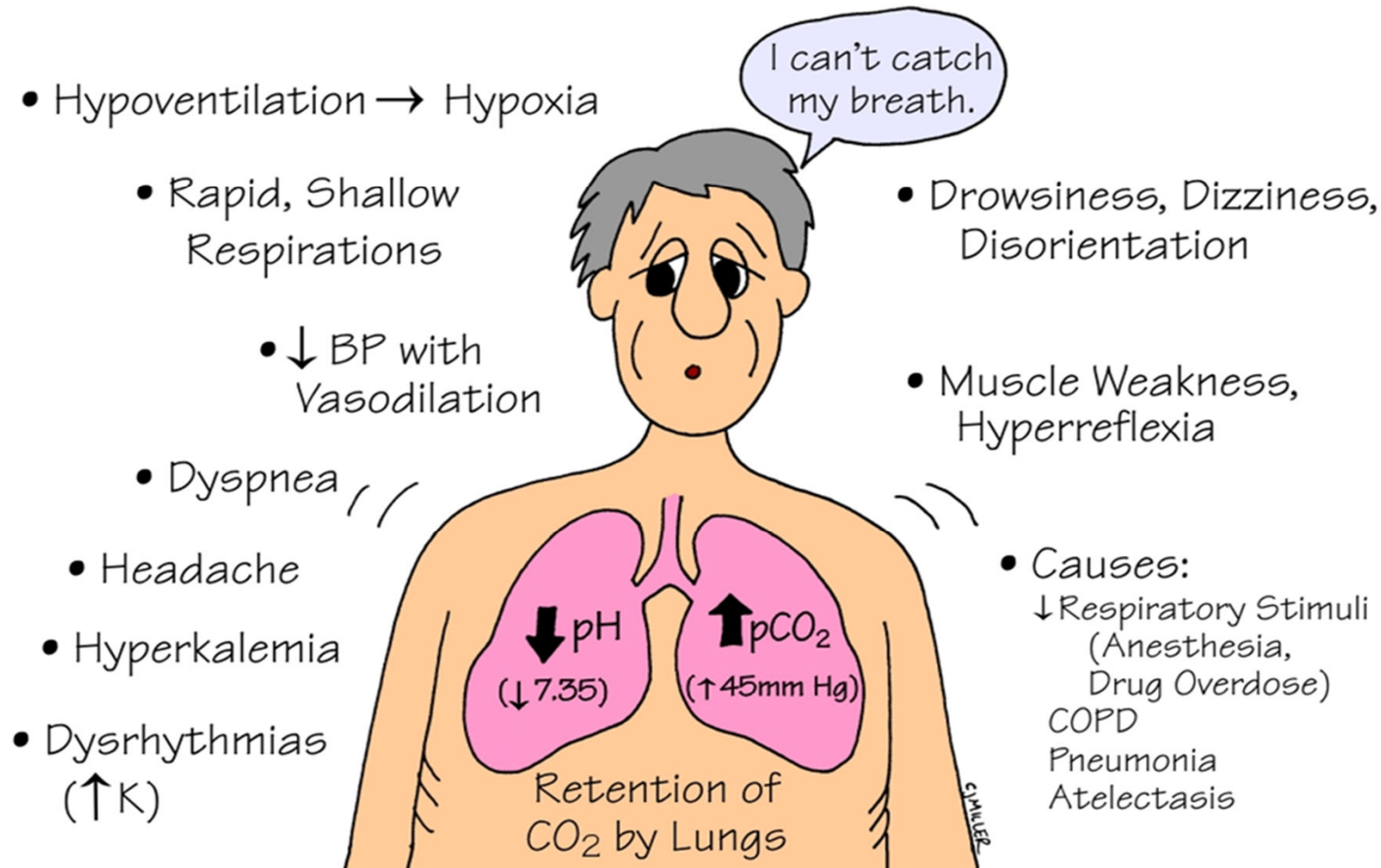


Signs and Symptoms associated with **Acidosis**:

- **Decrease excitability of CNS:**
 - Restlessness,
 - Headache,
 - Drowsiness,
 - Disorientation,
 - Coma
 - Death
- **Cardiovascular:**
 - Dysrhythmias,
 - Decreased cardiac contractility
 - Hypotension.
- **Increase electrolytes:**
 - Hyperkalemia
 - Hypercalcemia



RESPIRATORY ACIDOSIS





Compensation of respiratory acidosis:

- **Renal compensation:**
 - Increased the plasma HCO_3 concentration .
 - The increased PaCO_2 acts as a stimulus to increase the formation of H and HCO_3 from $\text{CO}_2 + \text{H}_2\text{O}$ in the renal tubular cells.
 - The renal H is secreted and the new HCO_3 is returned to the plasma.



Treatment of Respiratory Acidosis

- Restore ventilation
- IV lactate solution (RL)
- IV Sodium bicarbonate (NaHCO_3)
- Treat underlying dysfunction or disease
- Place the patient in semi-Flower position



Nursing Care of Respiratory Acidosis

Nursing care

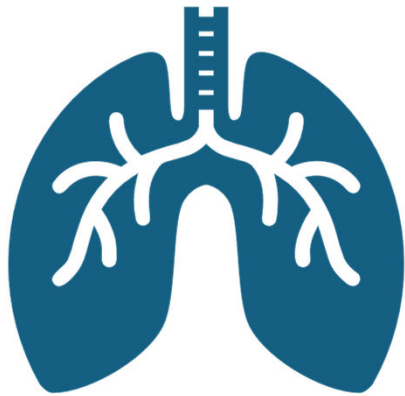
- Assess PaCO₂ levels in the arterial blood
- Observe for signs of respiratory distress: restlessness, anxiety, confusion, tachycardia

Intervention

- Encourage fluid intake
- Position patients with head elevated 30 degrees



Respiratory Alkalosis



- It is defined as a decrease in PaCO_2 caused by increased alveolar ventilation.
- **It is characterized by:**
 - $\text{pH} > 7.45$
 - $\text{PaCO}_2 < 35 \text{ mmHg}$
 - Compensatory decrease in HCO_3



Causes of Respiratory Alkalosis:

- **Hyperventilation:**

- Hypoxemia
- Anemia
- Fever
- Psychological dyspnea
- Early in exercises
- Angry

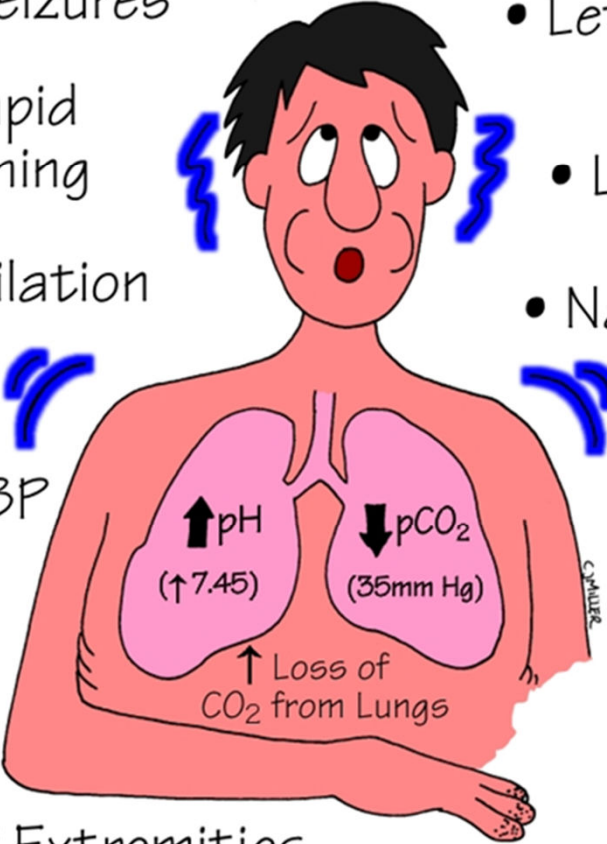


Signs and Symptoms associated with **Alkalosis**

- **Increase excitability of CNS:**
 - Lightheadedness,
 - Numbness,
 - Tingling,
 - Confusion,
 - Inability to concentrate
 - Blurred vision.
- **Decrease electrolytes:**
 - Hypokalemia
- **Hypertension**



RESPIRATORY ALKALOSIS

- Seizures
 - Lethargy & Confusion
 - Deep, Rapid Breathing
 - Light Headedness
 - Hyperventilation
 - Nausea, Vomiting
 - Tachycardia
 - Causes:
 - Hyperventilation (Anxiety, PE, Fear)
 - Mechanical Ventilation
 - ↓ or Normal BP
 - Hypokalemia
 - Numbness & Tingling of Extremities
- 



Compensation for respiratory alkalosis

Renal compensation:

The kidneys decrease plasma [HCO_3^-]:

Decrease reabsorption of the filtered HCO_3^- .

The decreased CO_2 decreases the generation of H by the tubular epithelial cells.



Treatment of Respiratory Alkalosis

- Treat underlying cause
- Reduce ventilation
- Breathe into a closed system (such as a paper bag)
- IV Chloride-containing solution (Sodium is absorbed with chloride in the kidney & allows the excretion of excess bicarbonate)



Nursing Care of Respiratory Alkalosis

Intervention

- In addition to giving sedatives as ordered, reassure the patient to relieve anxiety
- Encourage the patient to breathe slowly, which will retain carbon dioxide in the body



Kidneys

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



Metabolic acidosis:

- It is defined as a primary decrease in plasma bicarbonate concentration(HCO_3).
- **It is characterized by:**
 - $\text{pH} < 7.35$
 - $\text{HCO}_3 < 22 \text{ mEq/ L}$
 - Compensatory decrease in PaCO_2



Causes of metabolic acidosis:

1) Loss of HCO_3^- :

- Prolonged severe diarrhea

2) Decreased elimination of acids:

- Renal failure

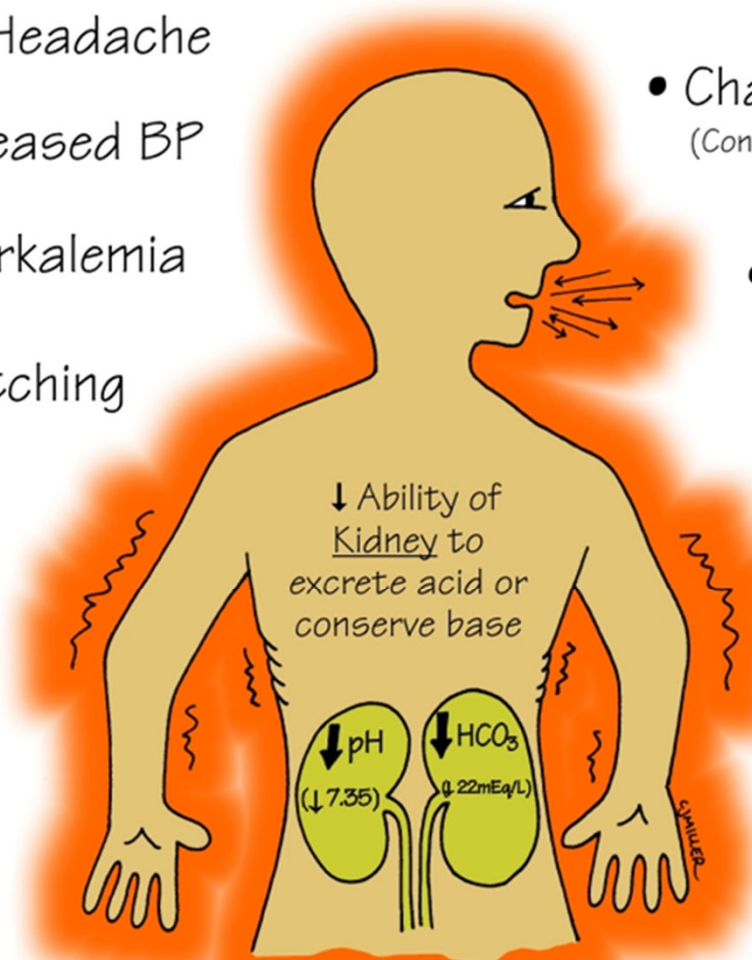
3) Excess production of Acids:

- Starvation
- Cardiac arrest
- Tissue hypoxia
- Sepsis
- Diabetic Ketoacidosis
- Shock
- Alcoholic Ketoacidosis



METABOLIC ACIDOSIS

- Headache
- Decreased BP
- Hyperkalemia
- Muscle Twitching
- Warm, Flushed Skin
(Vasodilation)
- Nausea, Vomiting, Diarrhea
- Changes in LOC
(Confusion, ↑ drowsiness)
- Kussmaul Respirations
(Compensatory Hyperventilation)
- Causes:
DKA
Severe Diarrhea
Renal Failure
Shock





Treatment of Metabolic Acidosis

❖ Treatment - IV lactate solution (RL)

❖ IV Sodium bicarbonate (NaHCO_3)

❖ Dialysis

❖ Treat underlying cause



Nursing Care of Metabolic Acidosis

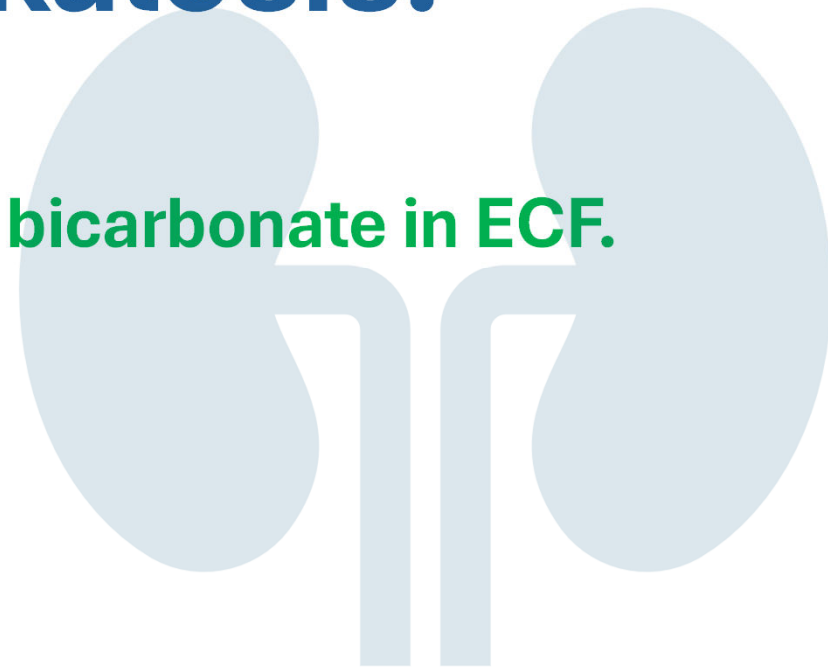
Assessment of the patient in metabolic acidosis should focus on vital signs, mental status, and neurologic status

Emergency measures to restore acid-base balance. Administer drugs and intravenous fluids as prescribed. Reassure and orient confused patients



Metabolic alkalosis:

- It results from an increase in bicarbonate in ECF.
- It is characterized by:
 - $\text{pH} > 7.45$
 - $\text{HCO}_3 > 26 \text{ mEq/ L}$
 - Compensatory increase in PaCO_2



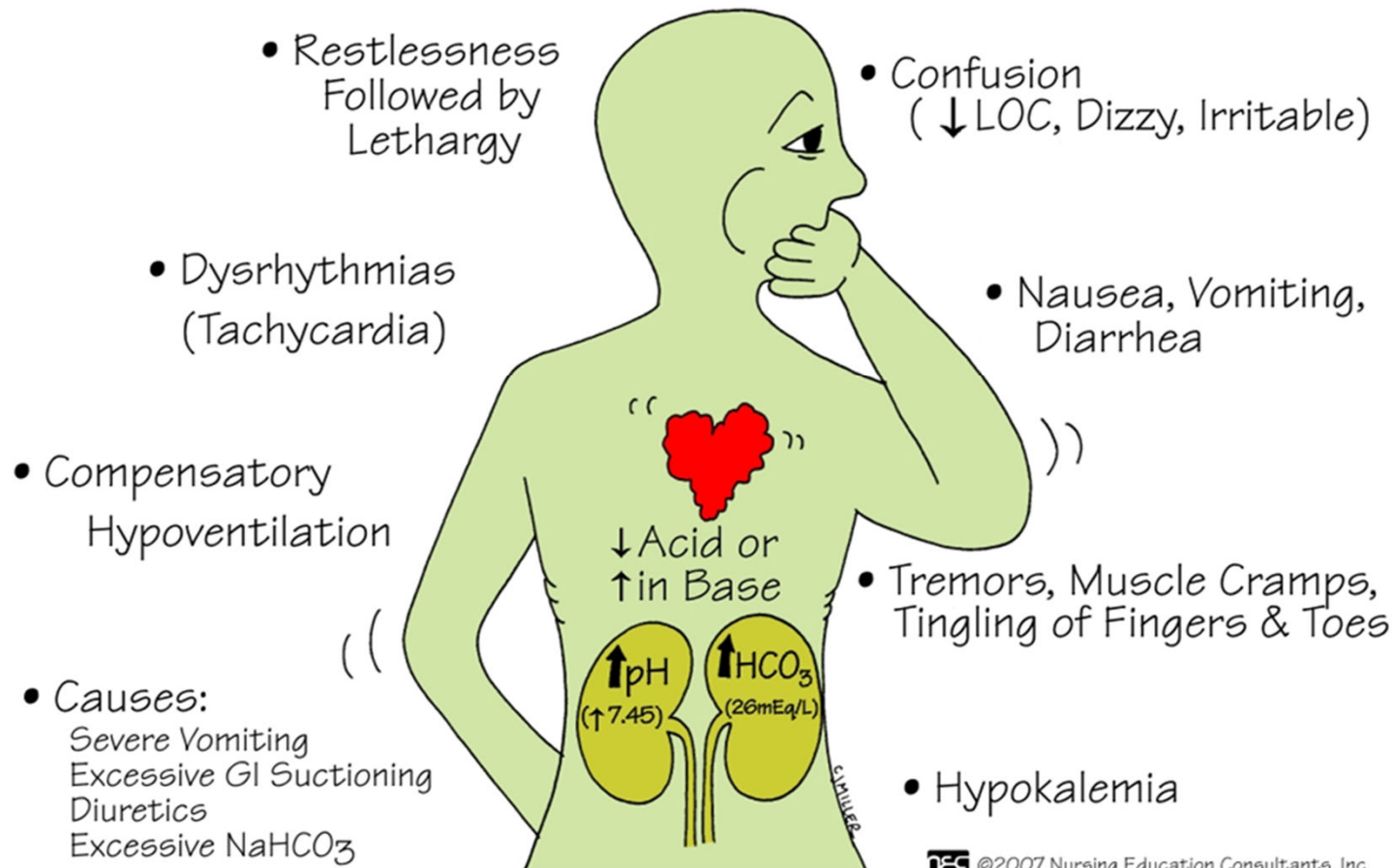


Causes of metabolic alkalosis

- Excess of base /loss of acid.
- Acute H^+ ion loss:
 - Vomiting
 - Gastric suctioning
 - Diuretics as: Frusemide, thiazide (Loss of potassium)
 - Cushing syndrome
- Excess intake of Alkali.
- IV $NaHCO_3$ administration.



METABOLIC ALKALOSIS





Treatment of Metabolic alkalosis

- Electrolytes to replace those lost - Ascorbic acid, tranexamic acid
- IV chloride-containing solution (Sodium is absorbed with chloride in the kidney & allows the excretion of excess bicarbonate)
- KCl inj. to replace both potassium & chloride
- Treat underlying disorder



Nursing Care of Metabolic Alkalosis

- Take vital signs and daily weight; monitor heart rate, respiration, and fluid gains and losses
- Keep accurate intake and output records, including the amount of fluid removed by suction
- Assess motor function and sensation in the extremities; monitor laboratory values, especially pH and serum bicarbonate levels



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