

IX. Respiratory Acidosis

Respiratory acidosis is the acid-base disturbance initiated by **an increase in PaCO₂**. **Primary hypercapnia** is a synonymous term.

RESPIRATORY ACIDOSIS

The diagram shows a person with a speech bubble saying "I can't catch my breath." The person's chest is open, showing the lungs. The left lung has a downward arrow labeled "pH (↓7.35)" and the right lung has an upward arrow labeled "PCO₂ (↑48mmHg)". Below the lungs, it says "Retention of CO₂ by Lungs".

- Hypoventilation → Hypoxia
- Rapid, Shallow Respirations
- ↓ BP
- Skin/Mucosa Pale to Cyanotic
- Headache
- Hyperkalemia
- Dysrhythmias (↑K⁺)
- Drowsiness, Dizziness, Disorientation
- Muscle Weakness, Hyperreflexia
- Causes:
 - Respiratory Depression (Anesthesia, Overdose, ↑ICP)
 - Airway Obstruction
 - ↓ Alveolar Capillary Diffusion (Pneumonia, COPD, ARDS, PE)

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Pathophysiology

The level of PaCO₂ is determined by the interaction of two factors, the rate of carbon dioxide production (V_{CO₂}) and the rate of alveolar ventilation (V_A), as follows:

↑ PaCO₂ = K x V_{CO₂} / V_A ↓ where K is a constant.

Most cases of respiratory acidosis reflect a **decrease in alveolar ventilation** leading to hypercapnia.

The **renal response to chronic hypercapnia** includes a transient increase in **chloride excretion** and generation of hypochloremia. This reduction in plasma chloride concentration balances the increase in plasma bicarbonate concentration, plasma anion gap remaining unchanged.

Causes:

1. **CNS depression:**
 - i) Sedatives.
 - ii) CNS disease.
 - iii) **Obesity-hypoventilation syndrome.**
2. **Pleural disease:**
 - i) Large pneumothoraxes.
 - ii) Pleural effusions).
3. **Lung disease:**
 - i. Chronic obstructive pulmonary disease(COPD), acute respiratory distress syndrome (ARDS).
 - ii. Musculoskeletal.
4. **Neuromuscular disorders** (kyphoscoliosis, Guillain-Barre syndrome, myasthenia gravis & polymyositis).

Clinical manifestations:

1- **Neurological:** “**hypercapnic encephalopathy**” is mainly represented by irritability, inability to concentrate, headache, anorexia, apathy, confusion, hallucinations, delirium, transient psychosis, progressive narcosis and might lead to **coma**.

2- **Cardiovascular:** Respiratory acidosis causes inhibition of myocardial contractility, decreases in both cardiac output and blood pressure might be observed in severe cases.

3- **Renal:** Salt and water retention.

X. RESPIRATORY ALKALOSIS

Respiratory alkalosis is the acid-base disturbance initiated by a reduction in PaCO_2 . Primary hypocapnia is a synonymous term.

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

Pathophysiology

1. Most cases of respiratory alkalosis reflect **an increase in alveolar ventilation**.
2. Primary decreases in carbon dioxide production are generally attended by parallel decreases in alveolar ventilation, thus preventing expression of respiratory alkalosis. However, in the presence of constant alveolar ventilation (i.e., mechanical ventilation), decreased carbon dioxide production (e.g., **sedation, skeletal muscle paralysis, hypothermia, hypothyroidism**) can cause respiratory alkalosis.

Adaptation

1. Acute adaptation

- a. It is completed within 5-10 min from onset of hypocapnia.
- b. It originates principally from alkaline titration of the body's non bicarbonate buffers (hemoglobin, intracellular proteins and phosphates, plasma proteins):



where HBuf refers to the acid component and Buffer⁻ to the base component of non-bicarbonate buffers.

2. Chronic adaptation

- a. It requires 2-3 days of sustained hypocapnia for completion.
- b. It originates from down regulation of renal acidification mechanisms
 - i. *A transient decrease in urinary net acid excretion* (mostly a fall in ammonium excretion).
 - ii. A persistent decrease in the rate of renal bicarbonate reabsorption.

Causes:

Primary hypocapnia is the most frequent acid-base disturbance encountered, occurring in **normal pregnancy and high-altitude residence**.

1- Hypoxemia or tissue hypoxia:

- a) High altitude.
- b) Bacterial or viral pneumonia.
- c) Aspiration of food.
- d) foreign body or vomitus.
- e) Severe anemia.
- f) Drowning.
- g) Hypotension...etc.

2- Drugs or hormones: Nikethamide, ethamivan, Doxapram, Xanthines, Salicylates, Catecholamines, Angiotensin II, Vasopressor agents, Progesterone, Nicotine

3- Miscellaneous:

- a) Pregnancy.
- b) Sepsis.
- c) Hepatic failure.
- d) Mechanical hyperventilation.
- e) Heat exposure.

Clinical manifestations

1- Central Nervous System:

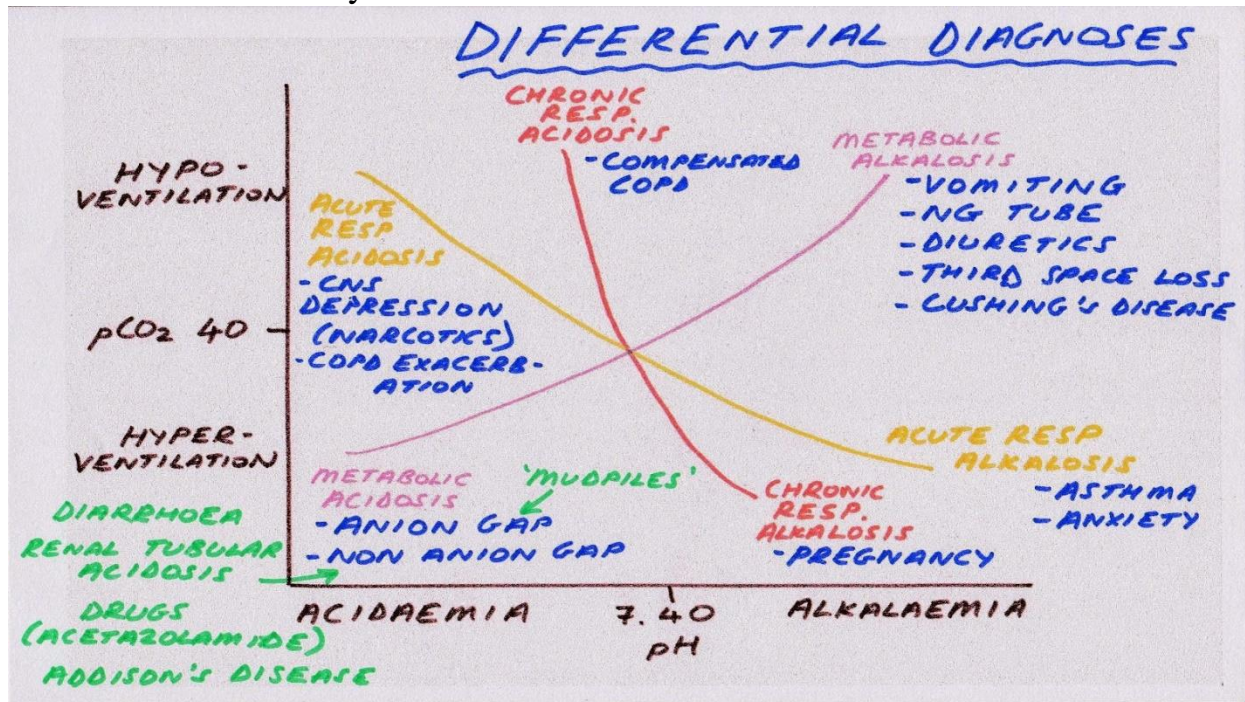
- Reduction in intracranial pressure,
- Light-headedness,
- Confusion.
- Generalized seizures.

2- Cardiovascular System:

- Normal or decreased blood pressure.
- Cardiac arrhythmias.
- Peripheral vasoconstriction.
- Angina pectoris and even Ischemic changes.

3- Neuromuscular System:

- Numbness and paresthesias of the extremities.
- Muscle cramps.
- Circumoral numbness.
- Laryngeal spasm.
- Manifestations of tetany.



Whenever the pH and the pCO₂ are moving in the same direction (i.e. up or down), a metabolic process is occurring. Whenever the pH and pCO₂ are moving in opposite directions, a respiratory process is occurring.

THANK YOU