# Alterations in Acid-Base Balance

Nursing Pathophysiology (N – 4)

Alyssa Jenny E. Tupaz, MA, RN

## Acid-Base Balances

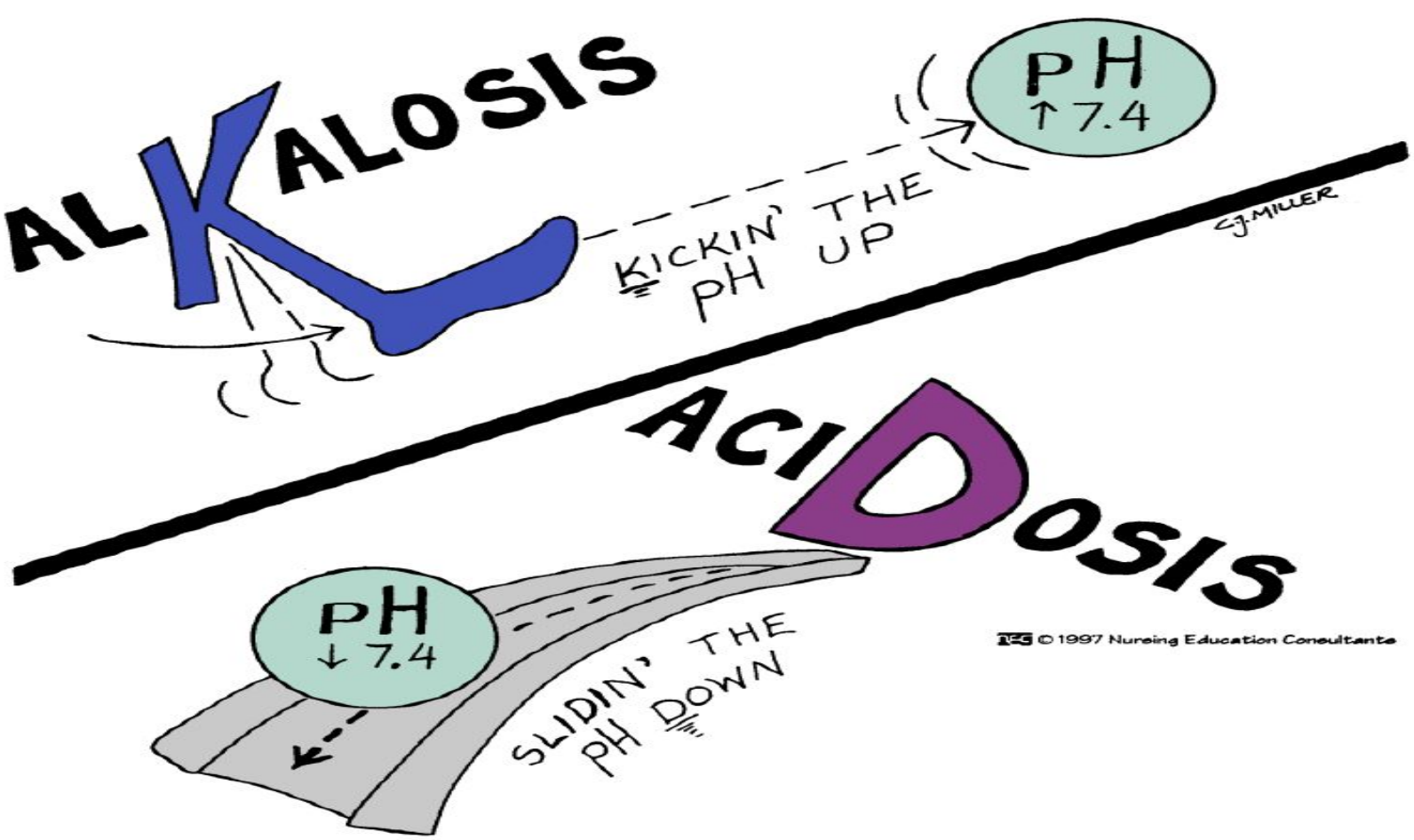
- PH 7.35-7.45
- Acids/Bases – hydrogen ion
- Buffer Systems – promote balance
- Bicarbonate/ Carbonic acid
- Alkalosis – above 7.45
- Acidosis – below 7.35

# Acid-Base Disorders

pathologic changes in **carbon dioxide partial pressure ($Pco_2$)** or **serum bicarbonate ($HCO_3^-$)** that typically produce abnormal arterial pH values.

- **Acidemia** is serum **pH < 7.35**
- **Alkalemia** is serum pH > 7.45
- **Acidosis** refers to physiologic processes that cause **acid accumulation** or **alkali loss**.
- **Alkalosis** refers to physiologic processes that cause **alkali accumulation** or **acid loss**.

# ACIDOSIS – ALKALOSIS



# Sources of Acids and Bicarbonate Ions

**Acids**

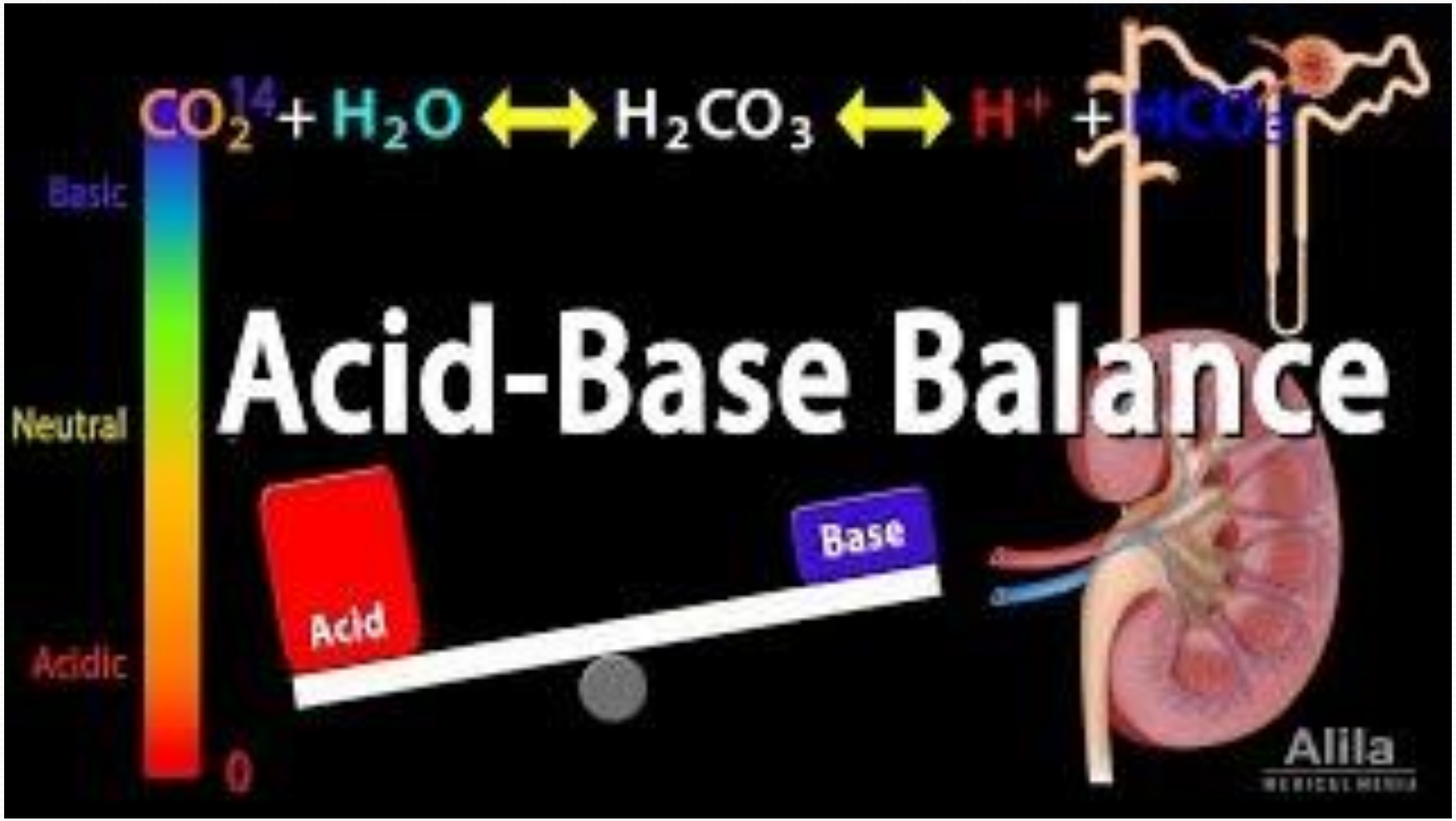
- Carbon dioxide
- Fatty acids and ketoacids
- Anaerobic – lactic acid and ketoacids
- Impaired cells

**Bicarbonate**

- Breakdown of carbonic acid, intestinal absorption, pancreatic production, movement of cellular bicarbonate in ECF and kidney reabsorption of bicarbonate

# Acid Base Regulatory Mechanisms

- Chemical Acid-Base Control
  - Bicarbonate  (ECF & ICF) and phosphate (ICF)
- Respiratory Acid Base Control
  - Carbon dioxide
- Renal Acid Base Control
  - Bicarbonate, acids, ammonium


$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$
Basic
Neutral
Acidic
14
0
Acid-Base Balance
Acid
Base
Alila

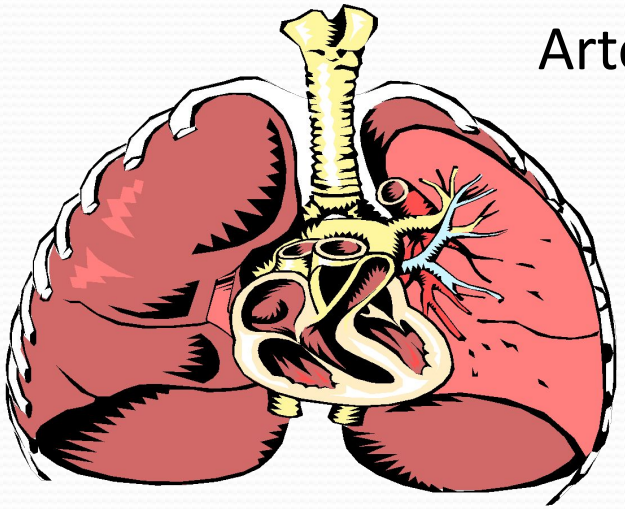
# Biological Compensation

**Respiratory**

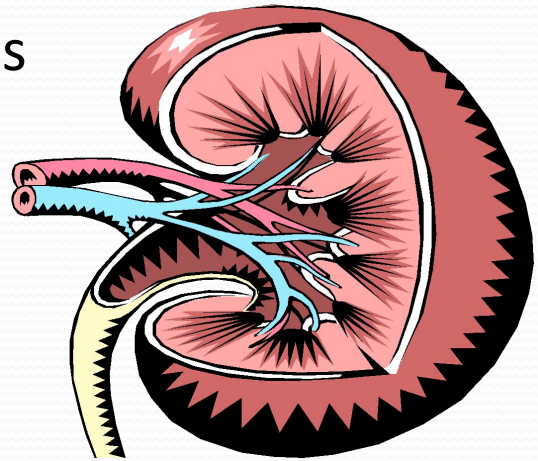
- Metabolic disorders – Diabetes, acute renal failure
- carbon dioxide retained or excreted

**Renal**

- In lung disorders – COPD
- Formation of acids or bicarbonate reabsorbed or excreted



Arterial Blood Gases (ABGs)



# Classification of Acid-Base Disorders

| ACIDOSIS | ALKALOSIS |
| --- | --- |
| **Respiratory acidosis** is $P_{CO_2}$ > 40 mm Hg (hypercapnia). Cause is<br>• Decrease in minute ventilation (hypoventilation) | **Respiratory alkalosis** is $P_{CO_2}$ < 38 mm Hg (hypocapnia). Cause is<br>• Increase in minute ventilation (hyperventilation) |
| **Metabolic acidosis** is serum $HCO_3^-$ < 24 mEq/L (< 24 mmol/L). Causes are<br>• Increased acid production<br>• Acid ingestion<br>• Decreased renal acid excretion<br>• Gastrointestinal or renal $HCO_3^-$ loss | **Metabolic alkalosis** is serum $HCO_3^-$ > 28 mEq/L (> 28 mmol/L). Causes are<br>• Acid loss<br>• $HCO_3^-$ retention |

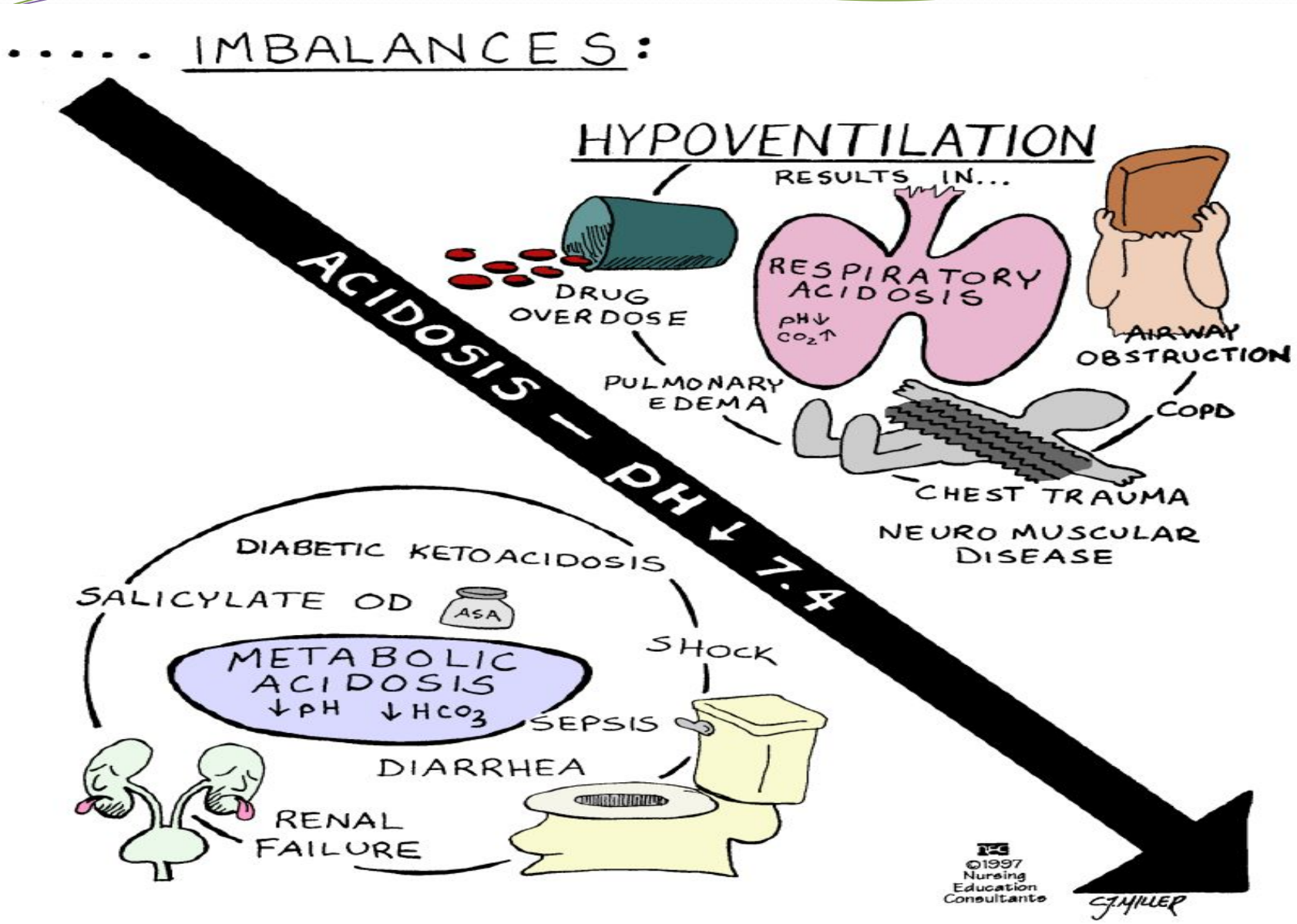
# Acidosis

## RESPIRATORY

- Respiratory Depression
- Inadequate Chest Expansions
- Airway Obstruction
- Reduced Alveolar-capillary diffusion

## METABOLIC

- Overproduction of *Hydrogen* Ions
- Underelimination of *Hydrogen* Ions
- Underproduction of *Bicarbonate* Ions
- Overelimination of *Bicarbonate* Ions


..... IMBALANCES:
HYPOVENTILATION
RESULTS IN...
DRUG OVERDOSE
RESPIRATORY ACIDOSIS
pH↓ $CO_2$↑
AIRWAY OBSTRUCTION
PULMONARY EDEMA
COPD
CHEST TRAUMA
NEURO MUSCULAR DISEASE
ACIDOSIS - pH ↓ 7.4
DIABETIC KETOACIDOSIS
SALICYLATE OD
ASA
METABOLIC ACIDOSIS
↓pH ↓$HCO_3$
SHOCK
SEPSIS
DIARRHEA
RENAL FAILURE
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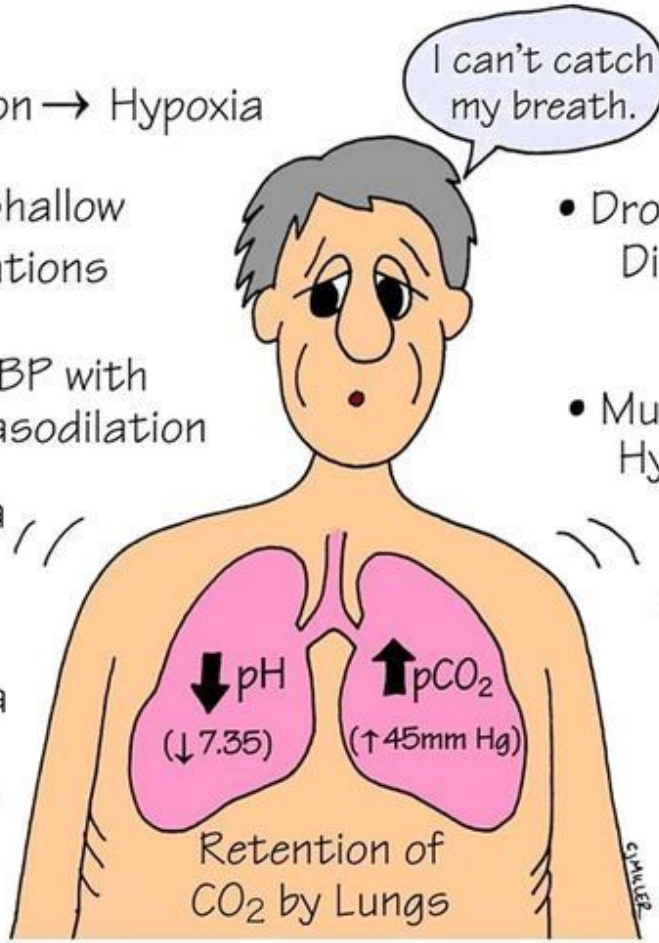
# RESPIRATORY ACIDOSIS




- Hypoventilation → Hypoxia
- Rapid, Shallow Respirations
- ↓ BP with Vasodilation
- Dyspnea
- Headache
- Hyperkalemia
- Dysrhythmias (↑K)
- Drowsiness, Dizziness, Disorientation
- Muscle Weakness, Hyperreflexia
- Causes:
  - ↓Respiratory Stimul (Anesthesia, Drug Overdose)
  - COPD
  - Pneumonia
  - Atelectasis



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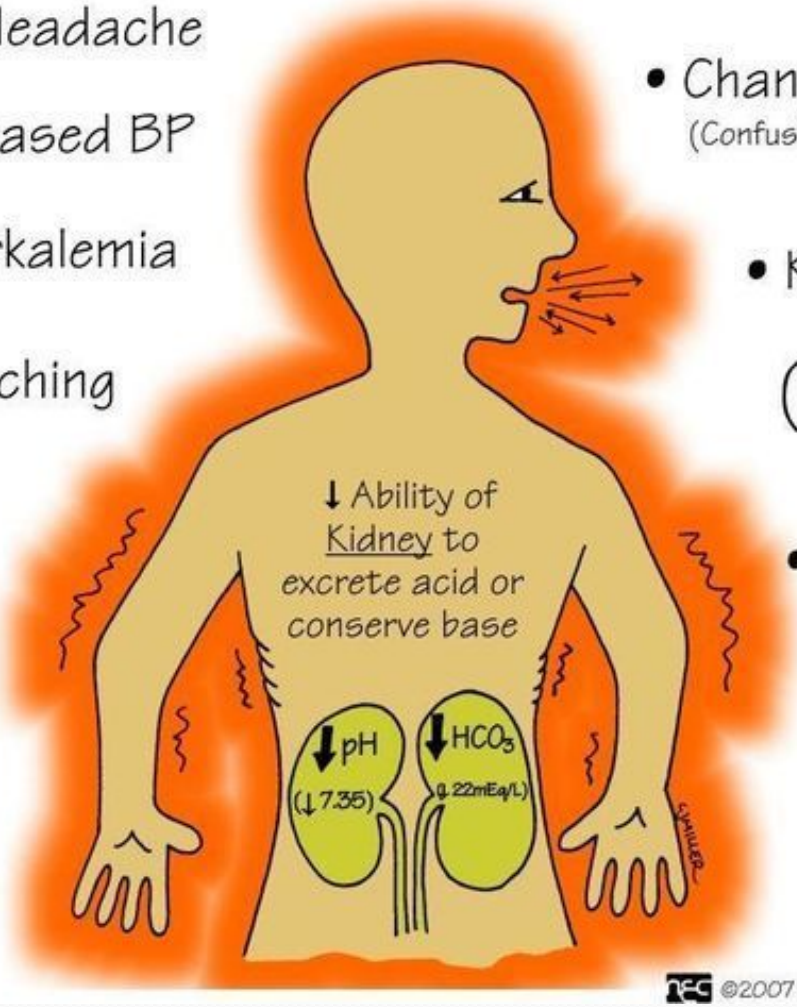
# METABOLIC ACIDOSIS

- 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

# Assessment of Acidosis

- History – age, cause, diet, medications, illness
- Physical Assessment
  - Lethargic, confusion, coma
  - Muscle weakness, deep tendon reflexes, flaccid paralysis; skin in metabolic - warm, dry, pink (due to vasodilation); skin in respiratory – pale to cyanotic.
  - Heart rate ⇧, then in severe cases, heart rate ⇩ ,
    BP, monitor vs, O2 sat, EKG
  - ⇩Mental status – confused, uncooperative
  - Metabolic acidosis – lo bicarbonate; Respiratory acidosis – elevated carbonic acid ($CO_2$)

# Treatment for Acidosis

- Metabolic
  - Hydration
  - Treat cause – diabetic Ketoacidosis – insulin; antidiarrheal for diarrhea
  - Dialysis – renal failure
  - Monitor VS, EKG
  - Assess for complications
- Respiratory
  - Oxygen, bronchial dilators, dry pulmonary secretions, breathing exercise, postural drainage
  - Monitor oxygen sat levels, VS, EKG
  - Assess for complications

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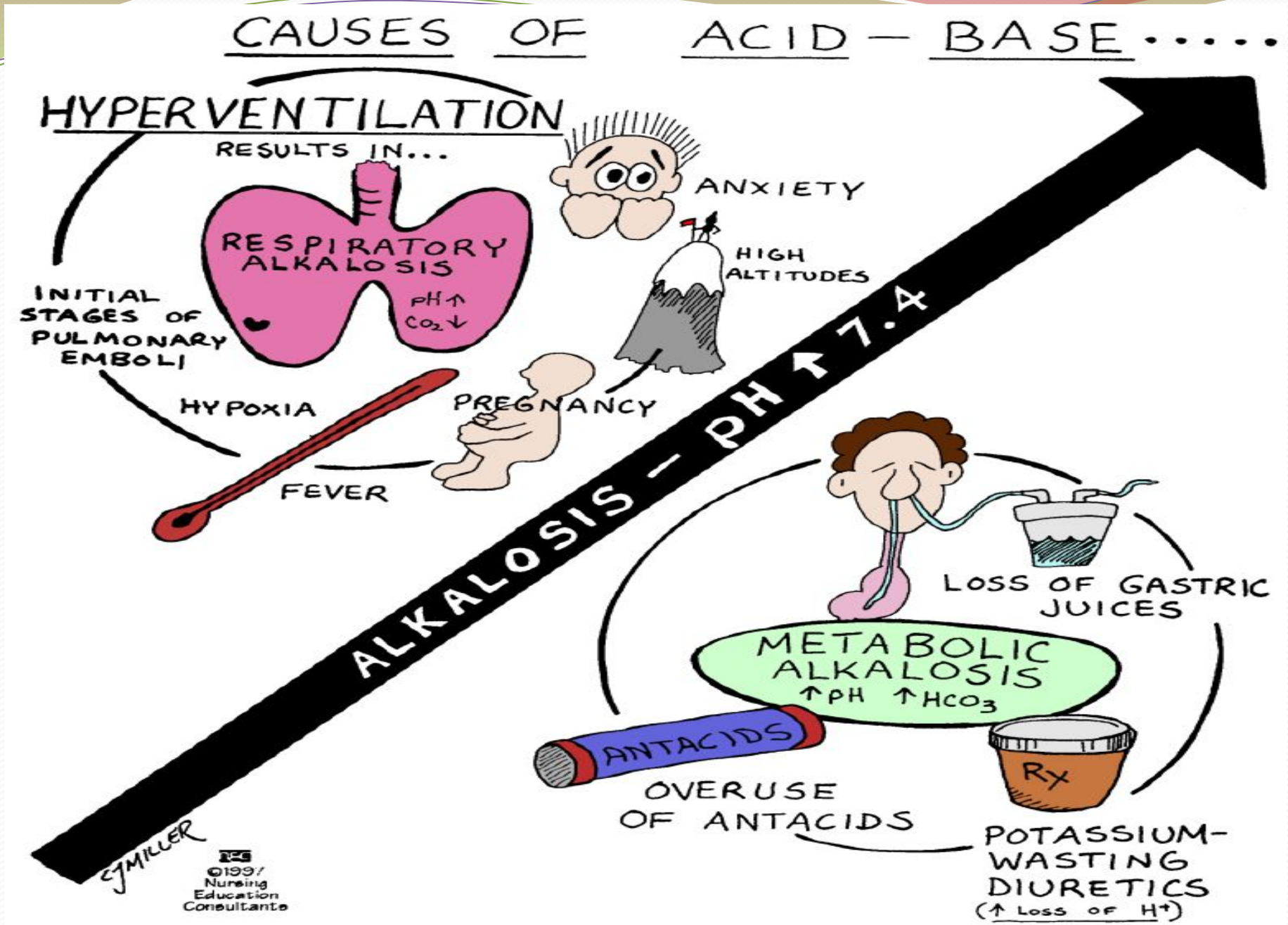
CAUSES OF ACID – BASE.....
HYPERVENTILATION
RESULTS IN...
RESPIRATORY ALKALOSIS
pH ↑
$CO_2$ ↓
ANXIETY
HIGH ALTITUDES
PREGNANCY
FEVER
HYPOXIA
INITIAL STAGES OF PULMONARY EMBOLI
ALKALOSIS – pH ↑ 7.4
LOSS OF GASTRIC JUICES
METABOLIC ALKALOSIS
↑pH ↑$HCO_3$
ANTACIDS
OVERUSE OF ANTACIDS
Rx
POTASSIUM-WASTING DIURETICS
(↑ Loss of $H^+$)
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# Alkalosis

## METABOLIC

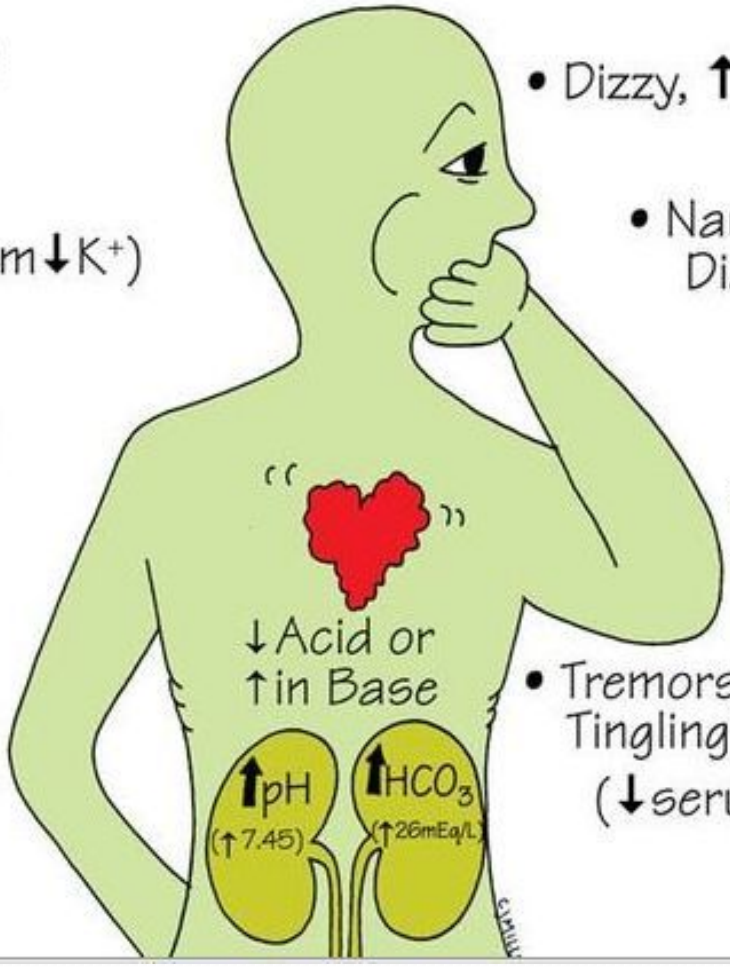
- Base Excess
- Acid Deficits

## RESPIRATORY

- Loss of carbonic acid in hyperventilation
- Anxiety, fear or improper settings on mechanical ventilators
- Hyperventilation direct stimulation of CNS – fever, metabolic acidosis, drugs - salicylates

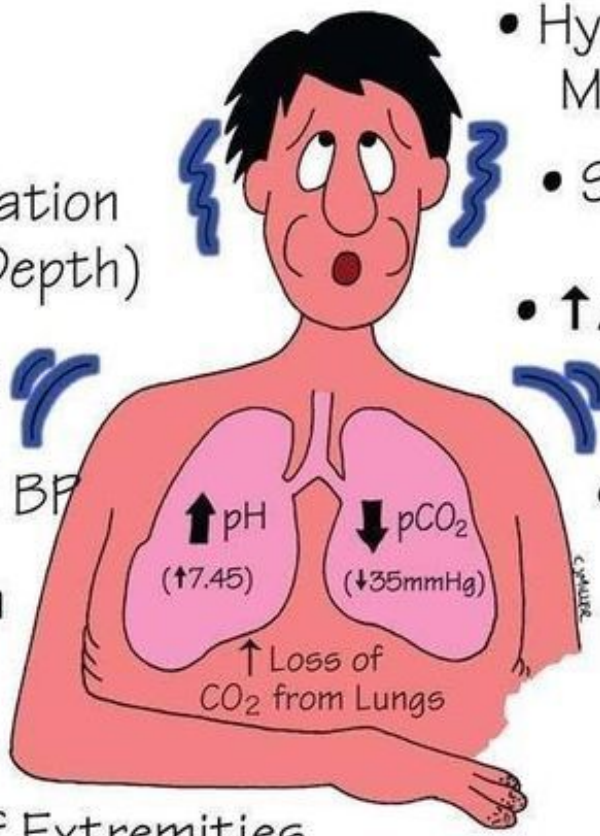
# METABOLIC ALKALOSIS

- Confusion
- Dysrhythmias (Tachycardia from ↓$K^+$)
- Compensatory Hypoventilation
- Causes:
  - ↑ $HCO_3$ (Antacids, admin of sodium bicarbonate)
  - ↓$H^+$ (NG Suctioning, Prolonged Vomiting, Hypercortisolism)




- Dizzy, ↑Irritability
- Nausea, Vomiting, Diarrhea
- ↑Anxiety, Seizures
- Tremors, Muscle Cramps, Tingling of Fingers & Toes (↓serum $Ca^{++}$)

# RESPIRATORY ALKALOSIS




- Hyperventilation (↑Rate & Depth)
- Tachycardia
- ↓or Normal BP
- Hypokalemia
- Numbness & Tingling of Extremities
- Hyper Reflexes & Muscle Cramping
- Seizures
- ↑Anxiety, ↑Irritablity
- Causes:
  - Hyperventilation (Anxiety, PE, Fear)
  - Mechanical Ventilation

# Assessment of Alkalosis

- Physical Assessment
  - CNS- dizziness, agitation confusion, hyperreflexia, parathesia, Chvostek's and Trousseau's signs.
  - Cramps, twitches, charley horses, deep tendon reflexes hyperactive, tetany, weak muscles, poor hand grasp
  - Heart rate ⇧, pulse thready, BP ⇩
- ⇧Rate and depth of respirations
- Laboratory
  - Metabolic – elevated bicarbonate
  - Respiratory – low bicarbonate and carbonic acid

# Treatment for Alkalosis

- Treat the cause
  - Correct electrolyte imbalances; remove if excess or administer if low
  - Hydration
  - Antiemetic for upper GI distress
  - Monitor IV fluids, VS, ABG's, I&O, oxygen, respiratory and cardiac (EKG)
  - Assess for complications

# ACID BASE MNEMONIC

## (ROME)

**R** **R**espiratory

**O** **O**pposite

pH ↑ $PCO_2$ ↓ Alkalosis

pH ↓ $PCO_2$ ↑ Acidosis

**M** **M**etabolic

**E** **E**qual

pH ↑ $HCO_3$ ↑ Alkalosis

pH ↓ $HCO_3$ ↓ Acidosis

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From Bobbi Emmons, MS, RN

# Interpretation of Acid Base Disturbance

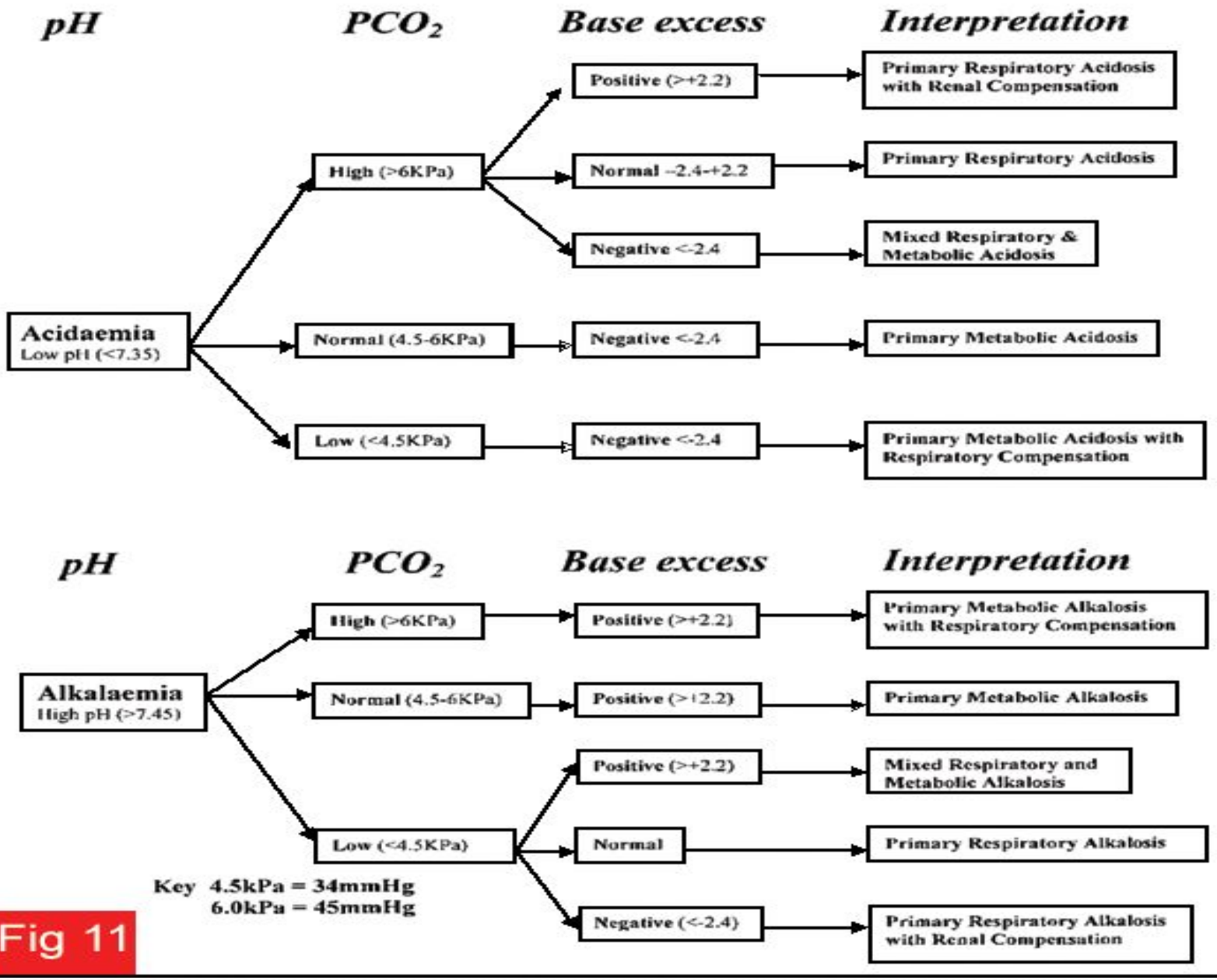


Fig 11

# Exercise:

1. pH 7.51, $pCO_2$ 40, $HCO_3^-$ 31:
   a. Normal
   b. Uncompensated metabolic alkalosis
   c. Partially compensated respiratory acidosis
   d. Uncompensated respiratory alkalosis

**B**

# Exercise:

2. pH 7.33, pCO2 29, HCO3- 16:
   a. Uncompensated respiratory alkalosis
   a. Uncompensated metabolic acidosis
   b. Partially compensated respiratory acidosis
   c. Partially compensated metabolic acidosis

**D**

# Exercise:

3. **pH 7.40, pCO2 40, HCO3- 24:**
   a. Normal
   b. Uncompensated metabolic acidosis
   c. Partially compensated respiratory acidosis
   d. Partially compensated metabolic acidosis

**A**

## Exercise:

4. **pH 7.12, $pCO_2$ 60, $HCO_3^-$ 29:** **C**
   a. Uncompensated metabolic acidosis
   b. Uncompensated respiratory acidosis
   c. Partially compensated respiratory acidosis
   d. Partially compensated metabolic acidosis