ARTERIAL BLOOD GAS INTERPRETATION

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LEARNING OUTCOMES

- Interpret arterial blood gas (ABG) values.
- Provide interventions based on ABG interpretation.

WHY SHOULD WE CARE?

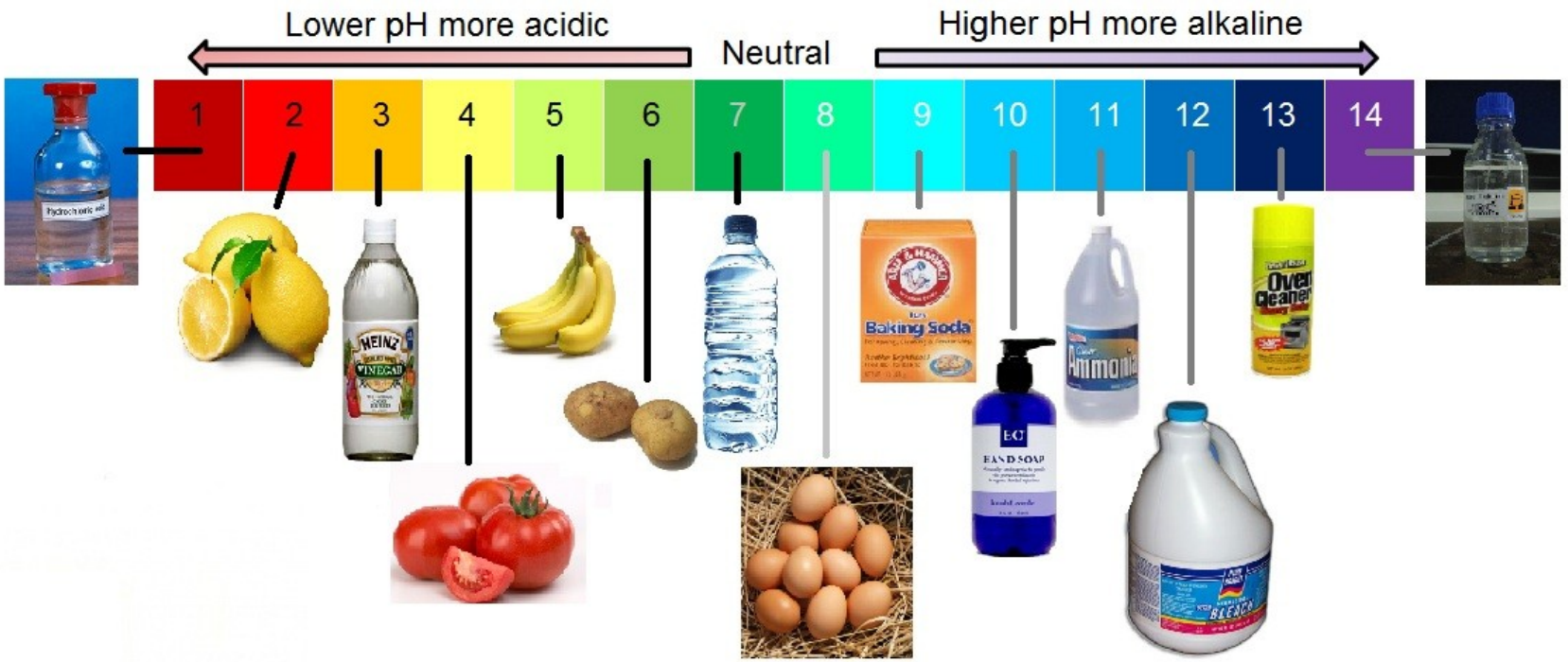
- ABG analysis allows us to:
  - Determine oxygenation status
    - Used in conjunction with pulse oximetry
  - Determine acid-base balance
    - Buffer system
    - Respiratory system
    - Renal system

WHAT DO WE LOOK AT?

Lab	Value
pH	7.35-7.45
PaO2	80-100 mm Hg
SaO2	>95%
PaCO2	35-45 mm Hg
HCO3-	22-26 mEq/L (mmol/L)

LET'S TALK PH

- 7 is neutral
- >7 is alkaline = Alkalosis
- <7 is acid = Acidosis

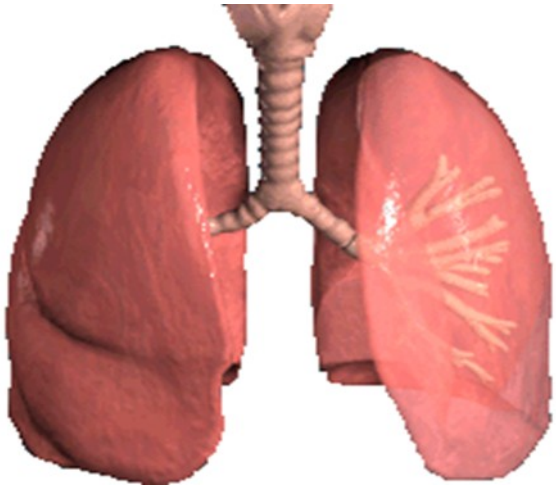


LET'S TALK CO2

- CO2 is the ACID component of our blood gas
- The body's fastest way of changing our pH
- Lungs regulate CO2 (acid) levels within minutes

To Compensate for Acidosis

***RR & Depth will increase**
***CO2 will be "blown off"**



To Compensate for Alkalosis

***RR & Depth will decrease**
***CO2 will be retained**

LET'S TALK BICARBONATE

- Bicarbonate is the BASE component of our blood gas.
- Kidneys regulate HCO3- (base) levels
- Slower system, takes hours to days

To Compensate for Acidosis

***H+ ions will be excreted & HCO3- will be retained**

To Compensate for Alkalosis

***H+ ions will be retained & HCO3- will be**

STEPS TO ABG ANALYSIS

- Step 1: Determine if pt. is in Acidosis or Alkalosis using the pH level
- Step 2: Use PaCO2 to determine respiratory effect on the body
- Step 3: Use HCO3 to determine metabolic effect on the body
- Step 4: Determine compensation
- Step 5: Determine oxygenation range

STEP 1: ANALYZE THE PH= ACIDOSIS OR ALKALOSIS

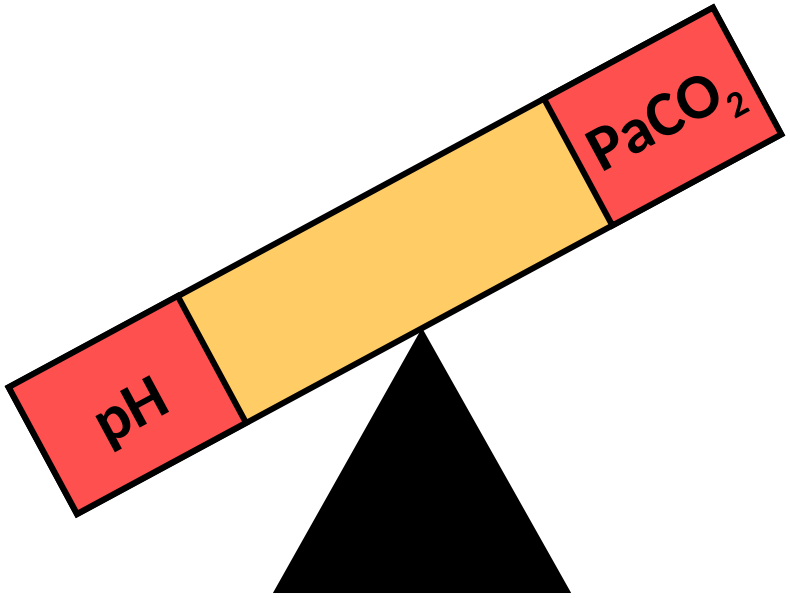
pH		
< 7.35	7.35 – 7.45	> 7.45
Acidosis	Normal or Compensated	Alkalosis

STEP 2: ANALYZE PACO2 TO DETERMINE RESPIRATORY EFFECT

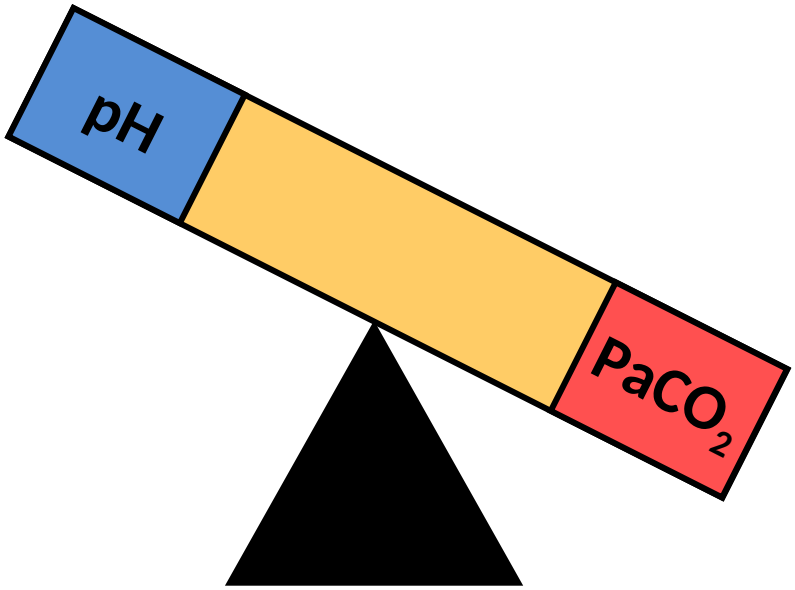
PaCO2		
< 35	35 - 45	> 45
Trends Toward Alkalosis	Normal or Compensated	Trends Towards Acidosis

RESPIRATORY EFFECTS

- The “See-Saw” Effect

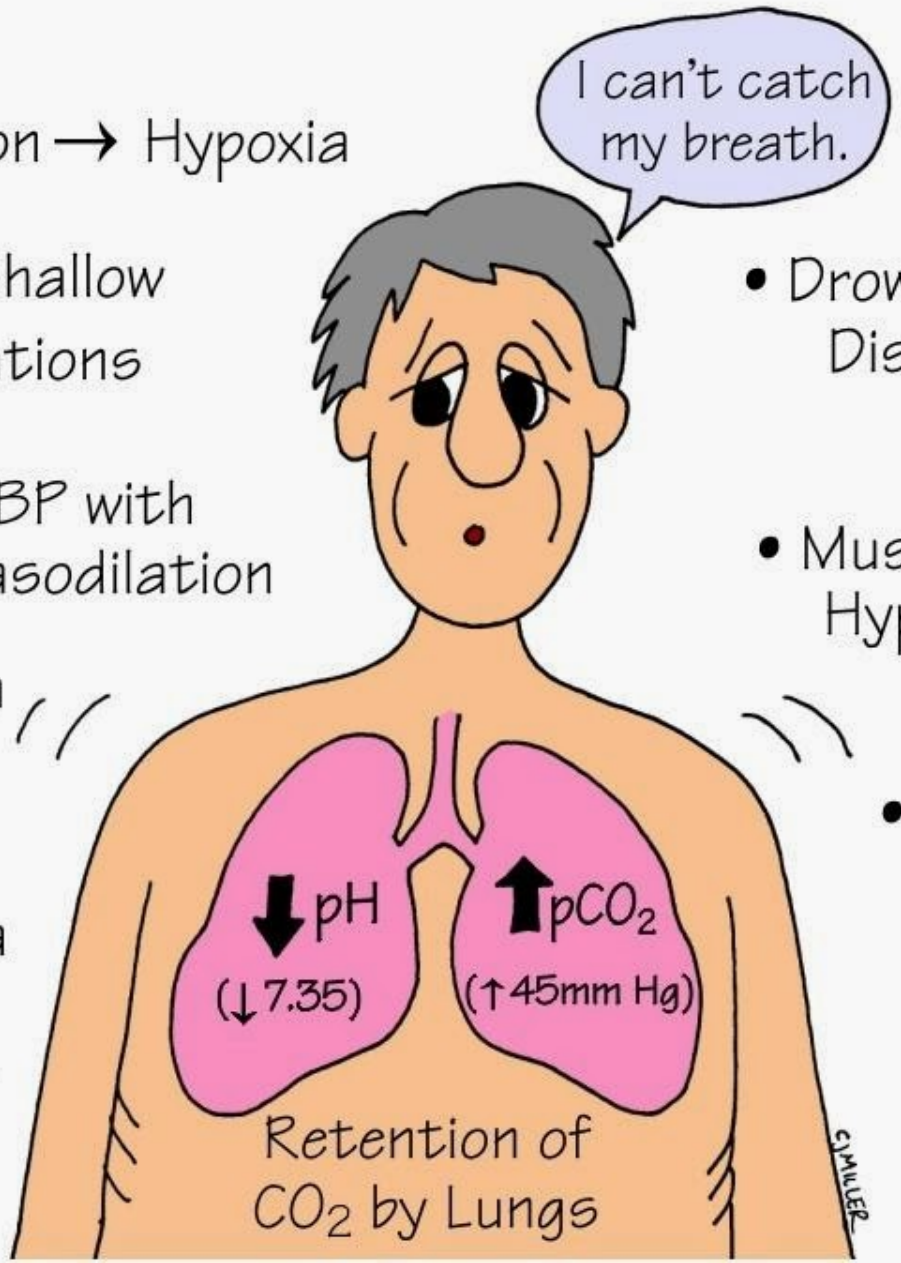


Respiratory Acidosis



Respiratory Alkalosis

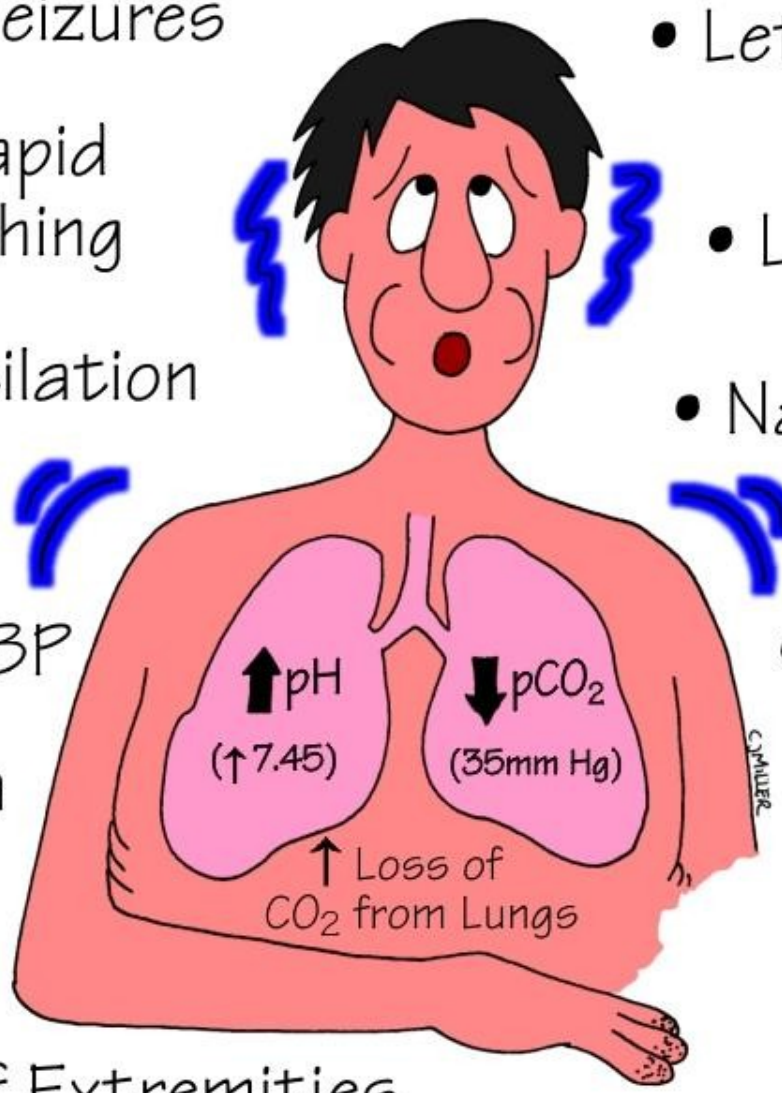
RESPIRATORY ACIDOSIS



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

RESPIRATORY ALKALOSIS

- Seizures
- Deep, Rapid Breathing
- Hyperventilation
- Tachycardia
- ↓or Normal BP
- Hypokalemia
- Numbness & Tingling of Extremities



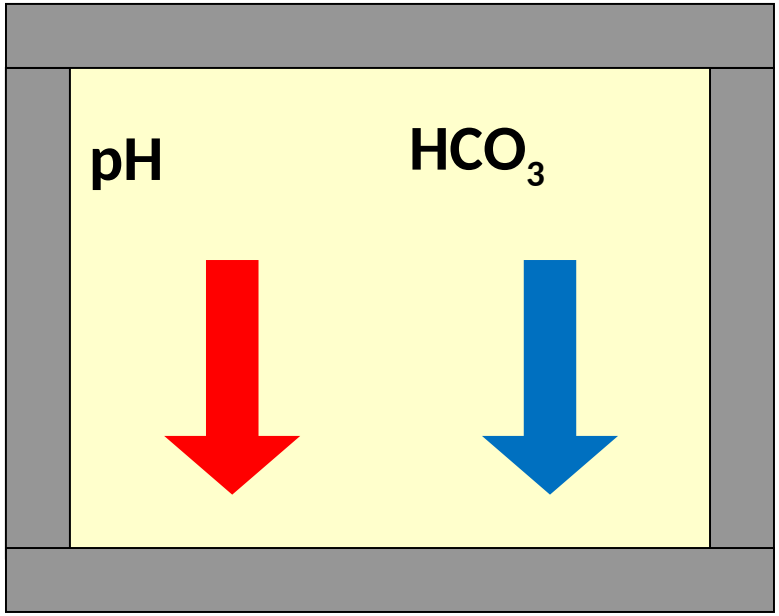
- Lethargy & Confusion
- Light Headedness
- Nausea, Vomiting
- Causes:
  - Hyperventilation
  - (Anxiety, PE, Fear)
  - Mechanical Ventilation

STEP 3: ANALYZE HCO3- TO DETERMINE METABOLIC EFFECT

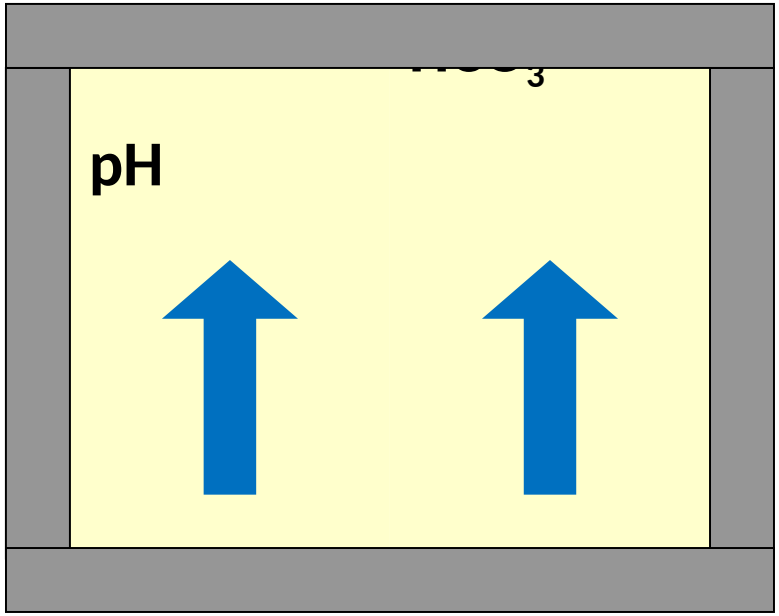
HCO3-		
< 22	22 - 26	> 26
Trends Towards Acidosis	Normal or Compensated	Trends Towards Alkalosis

METABOLIC EFFECTS

- The “Elevator” Effect



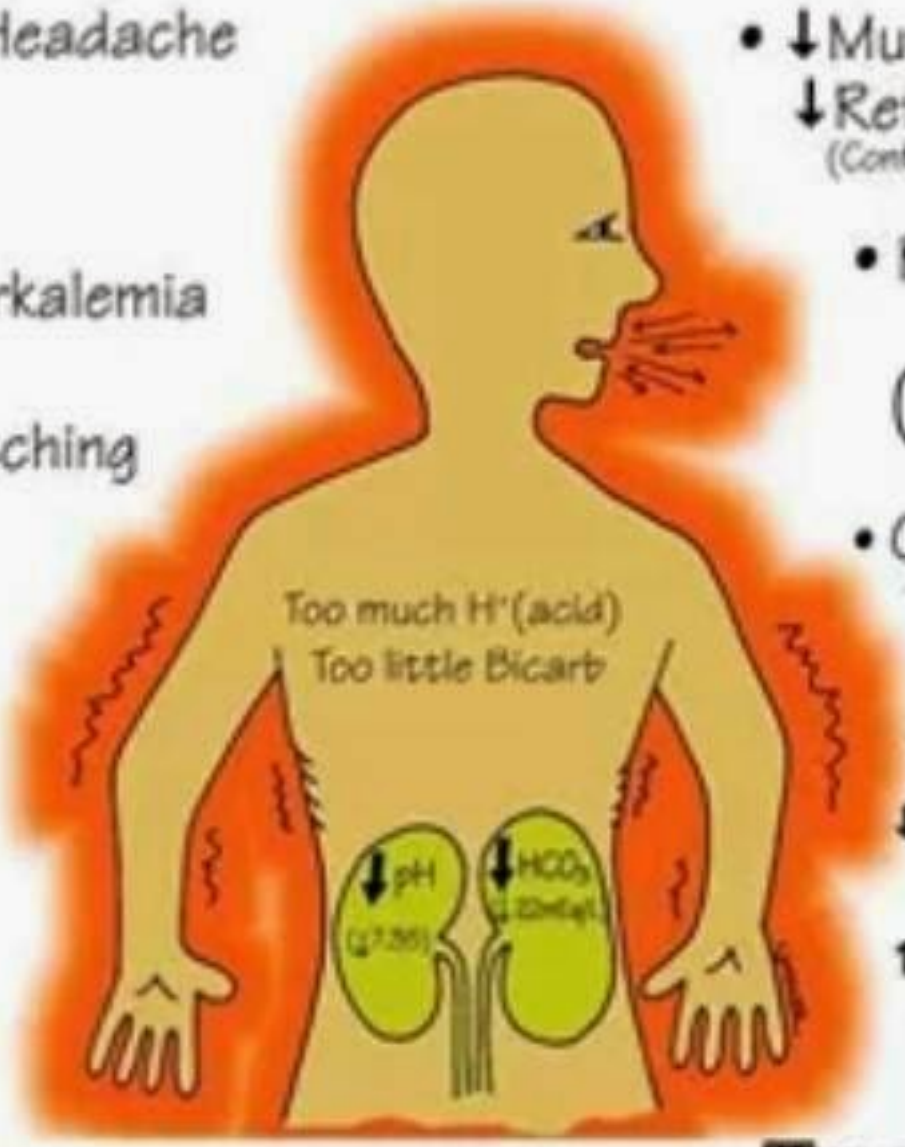
Metabolic Acidosis



Metabolic Alkalosis

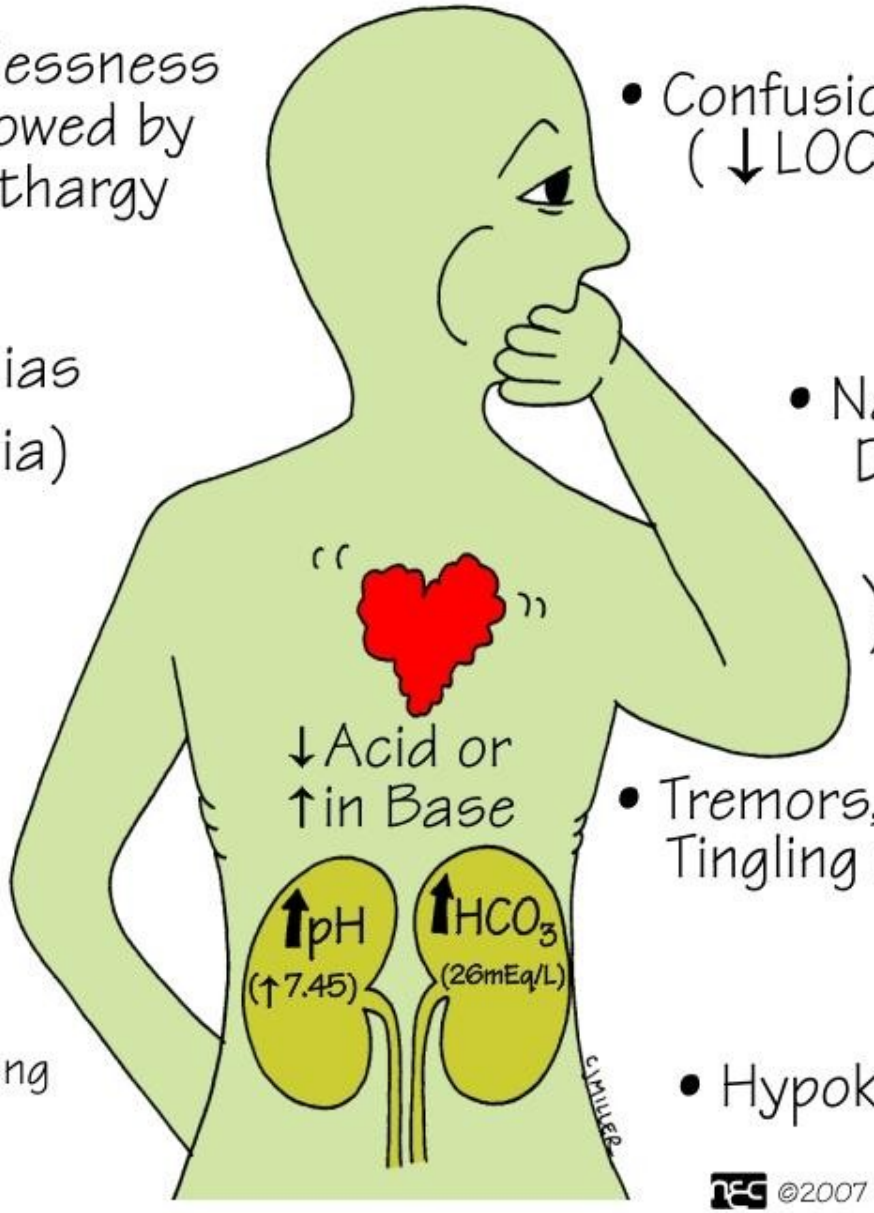
METABOLIC ACIDOSIS

- Headache
- ↓BP
- Hyperkalemia
- Muscle Twitching
- Warm, Flushed Skin (Vasodilation)
- Nausea, Vomiting



- ↓Muscle Tone, ↓Reflexes (Confusion, ↑Drowsiness)
- Kussmaul Respirations (Compensatory Hyperventilation)
- Causes:
  - ↑H+ Production (DKA, hyper-metabolism)
  - ↓H+ Elimination (renal failure)
  - ↓HCO_3 Production (dehydration, liver failure)
  - ↑HCO_3 Elimination (diarrhea, fistulas)

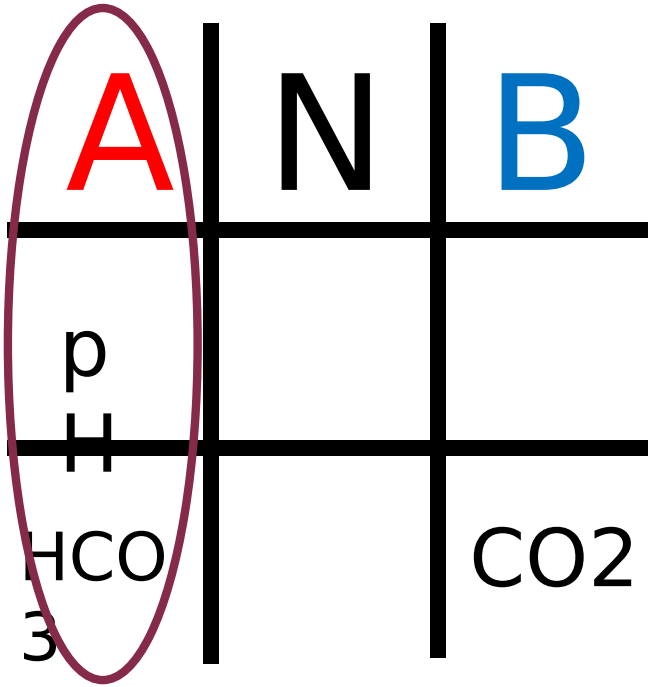
METABOLIC ALKALOSIS



- Restlessness Followed by Lethargy
- Confusion (↓LOC, Dizzy, Irritable)
- Dysrhythmias (Tachycardia)
- Nausea, Vomiting, Diarrhea
- Compensatory Hypoventilation
- Tremors, Muscle Cramps, Tingling of Fingers & Toes
- Causes:
  - Severe Vomiting
  - Excessive GI Suctioning
  - Diuretics
  - Excessive $NaHCO_3$
- Hypokalemia

TIC-TAC-TOE METHOD

- Mark the grid accordingly:
  - pH – 7.26 (A)
  - CO2 – 32 (B)
  - HCO3 –18 (A)
- Match it up!
- We have metabolic acidosis!



STEP 4: DETERMINE COMPENSATION

- Compensation present if pH is NORMAL with PaCO2 and/or HCO3- are ABNORMAL
- Component going in the SAME direction as pH is PRIMARY
- Component in the OPPOSITE direction of pH is COMPENSATORY

System Causing Imbalance	Compensating System
Respiratory (PaCO2)	Metabolic (HCO3-) *SLOW: 5-7 days
Metabolic (HCO3-)	Respiratory (PaCO2) *FAST: 12-24 hours

EXTENT OF COMPENSATION

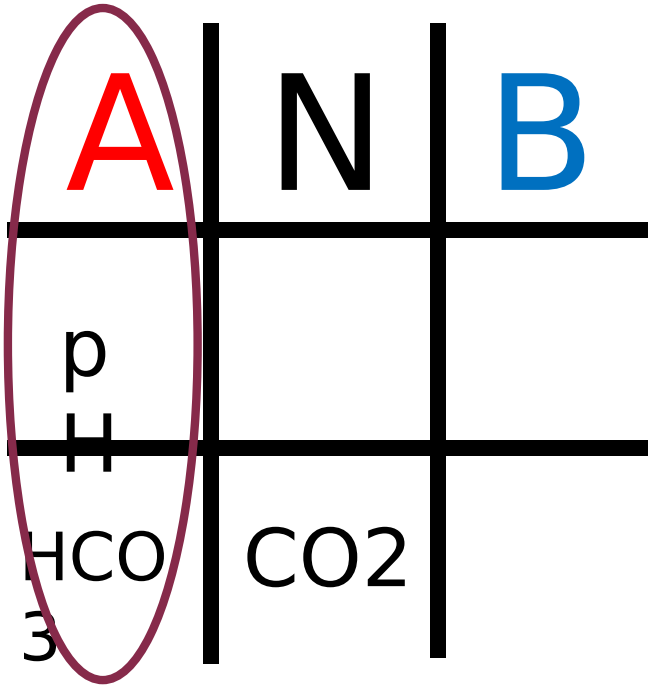
- ABSENT:
  - Which value does not match the pH? (PaCO2 or HCO3)
  - If the value that does **NOT** match pH is **NORMAL**, then **NO** compensation has taken place.

- pH – 7.15 (A)
- PaCO2 – 40 (N)
- HCO3 – 8 (A)

- Metabolic Acidosis
- No compensation
  - PaCO2 is normal **BUT** pH is abnormal

TIC-TAC-TOE

- Mark the grid accordingly:
  - pH – 7.15 (A)
  - CO2 – 40 (N)
  - HCO3 –8 (A)
- Match it up!
- If you have an abnormal pH with either normal CO2 or HCO3, you have *uncompensated*



*Metabolic acidosis with no compensation

EXTENT OF COMPENSATION

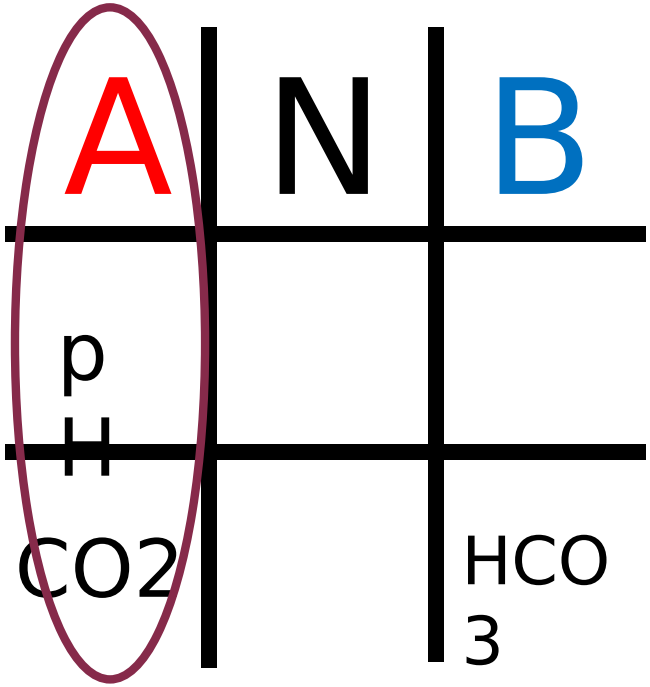
- Partial:
  - Which value does not match the pH? (PaCO2 or HCO3)
  - If the value that does not match pH is **ABNORMAL** & pH is **ABNORMAL**, then **PARTIAL** compensation exists.

- pH – 7.24 (A)
- PaCO2 – 90 (A)
- HCO3 - 38 (B)

- Respiratory Acidosis
- Partial Compensation
  - HCO3- & pH are BOTH abnormal.

TIC-TAC-TOE METHOD

- Mark the grid accordingly:
  - pH – 7.24 (A)
  - CO2 – 90 (A)
  - HCO3 –38 (B)
- Match it up!
- If your pH is abnormal and both CO2 and HCO3 are abnormal, you have *partially compensated*



*Partially compensated respiratory acidosis

EXTENT OF COMPENSATION

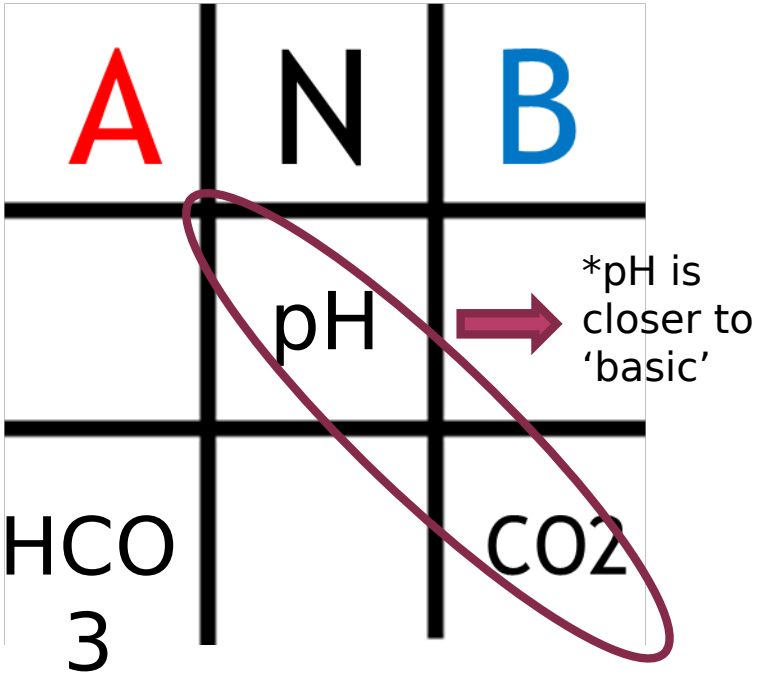
- Full:
  - What value does not match the pH? (PaCO2 or HCO3-)
  - If the value that does **NOT** match the pH is **ABNORMAL** but the pH is **NORMAL**, then **FULL** compensation has taken place.

- pH – 7.44 (N)(B)
- PaCO2 – 30 (B)
- HCO3 - 21 (A)

- Respiratory Alkalosis
- Full Compensation
  - HCO3- is abnormal, BUT the pH is normal.

TIC-TAC-TOE

- Mark your grid
  - pH – 7.44
  - CO2 - 30
  - HCO3 - 21
- Decide which way your pH is ‘leaning’
- Both abnormal CO2 and HCO3 indicates *fully compensated*



*We have fully compensated respiratory alkalosis

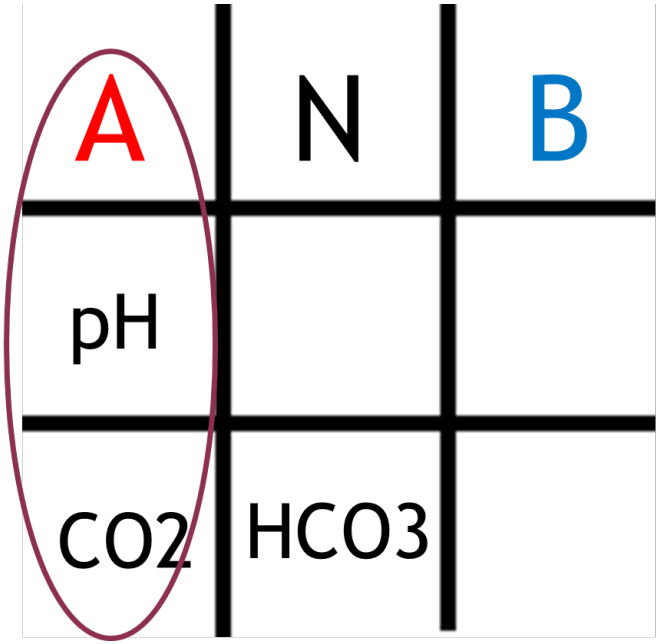
STEP 5: DETERMINE OXYGENATION

- PaO2 & SaO2 both assessed

Normal	80-100 mmHg
Mild Hypoxemia	70-80 mmHg
Moderate Hypoxemia	60-70 mmHg
Severe Hypoxemia	<60 mmHg

PRACTICE - GO TO KAHOOT.IT

- A 55 year-old is recovering from an exploratory laparotomy in the PACU. The nurse notices the patient's RR is 7/ minute, demonstrates shallow breathing and has no response to stimuli. The nurse assesses the ABC's and obtains a STAT ABG.

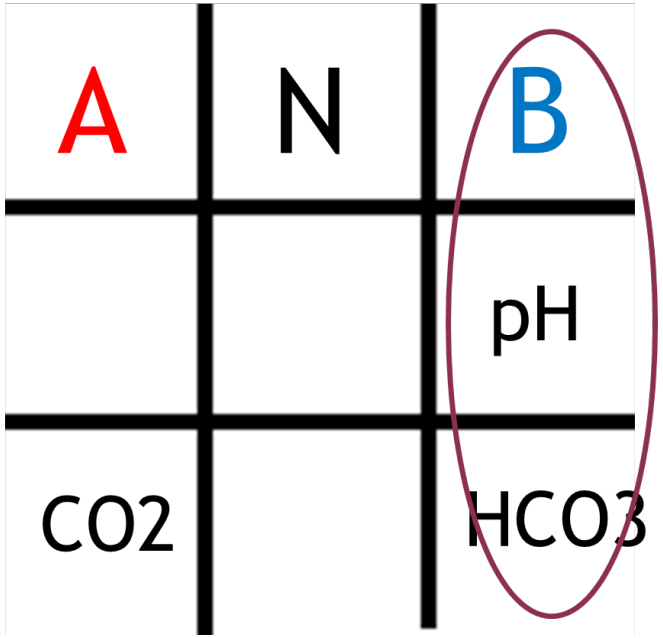


- pH = 7.15
- PaCO2 = 68
- HCO3 = 22 mEq/L
- PaO2 = 68 mmHg

- Uncompensated Respiratory Acidosis with Moderate Hypoxemia

PRACTICE

- A 79 year-old is admitted to the emergency room with nausea, vomiting and abdominal pain that has developed diarrhea after eating a 3 month old sandwich.



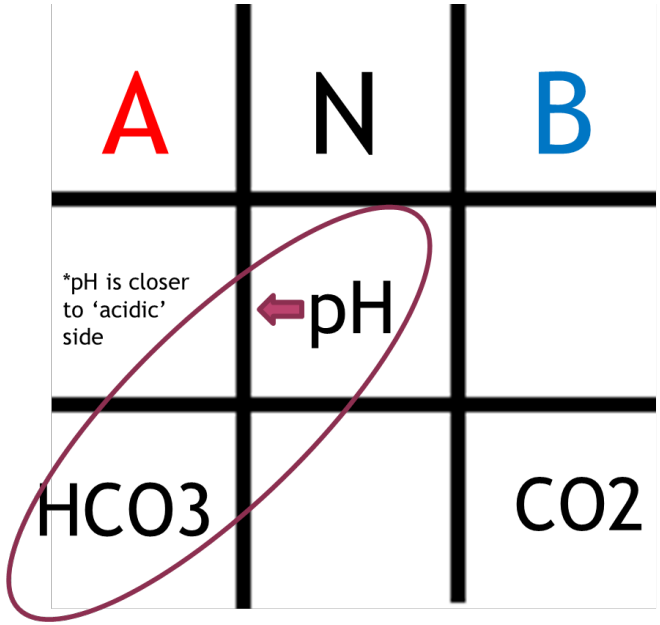
- pH= 7.55
- PaCO2 = 48
- HCO3 = 47.2
- PaO2 = 57.7

- Partially Compensated Metabolic Alkalosis with Severe Hypoxemia

PRACTICE

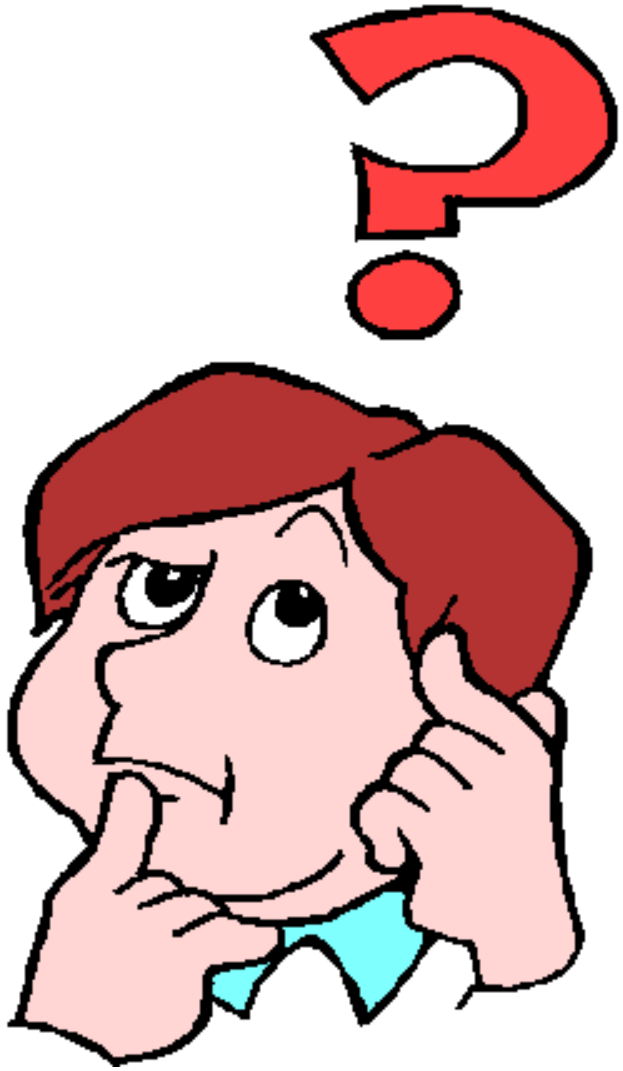
- A 65 year-old is admitted to the emergency room with inability to urinate and admits to taking an unknown number of aspirin over the last 24-hour period because of a severe headache. Vital signs are: T=98.5, Pulse= 92, RR=30 and deep. Routine blood test and ABG reveals:

- pH= 7.37
- PaCO2= 30
- HCO3 = 17
- PaO2 = 80

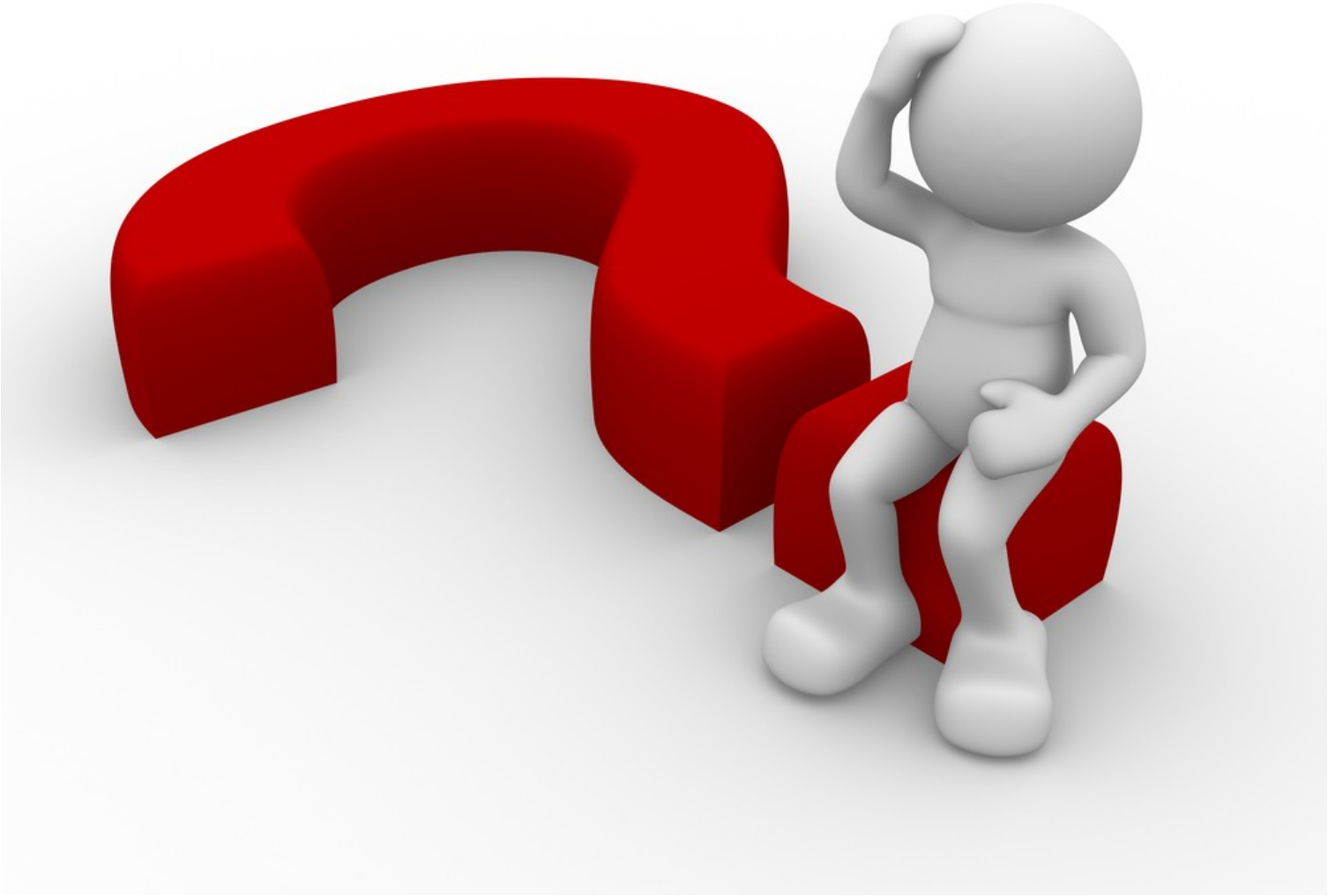


- Fully Compensated Metabolic Acidosis with Normal Oxygenation

WHAT DO I DO???



***YOU MUST FIGURE OUT WHAT IS GOING ON AND CORRECT THE CAUSE OF THE IMBALANCE. MANAGE SYMPTOMS UNTIL YOU CAN TREAT THE CAUSE!



CASE STUDY

- Mrs. Puffer is a 35-year-old single mother. She reports to the ED in the early morning with shortness of breath. She has cyanosis of the lips. She has had a productive cough for 2 weeks. Her temperature is 102.2, blood pressure 110/76, heart rate 108, respirations 32, rapid and shallow. Breath sounds are diminished in both bases, with coarse rhonchi in the upper lobes. Chest X-ray indicates bilateral pneumonia.
- ABG results are:
- pH= 7.44
- $PaCO_2$= 28
- HCO_3= 21
- PaO_2= 54

- What does our ABG tell us?
- What could we do to help this patient?

CASE STUDY

- Mr. Worried is a 52-year-old widow**ER**. He is retired and living alone. He enters the ED complaining of shortness of breath and tingling in fingers. His breathing is shallow and rapid. He denies diabetes; blood sugar is normal. There are no EKG changes. He has no significant respiratory or cardiac history. He takes several antianxiety medications. He says he has had anxiety attacks before. While being worked up for chest pain an ABG is done and results are:
- pH= 7.48
- $PaCO_2$= 28
- HCO_3= 22
- PaO_2= 85

- What does our ABG tell us?
- What could we do to help this patient?

CASE STUDY

- You are the critical care nurse about to receive Mr. Sweet, a 24-year-old being admitted for DKA (diabetic ketoacidosis). In report you learn that his blood glucose on arrival was 780. He received 10 unites of regular insulin IV X2 doses in the ED.

ABG results are:

- pH= 7.33
- PaCO2= 25
- HCO3=12
- PaO2= 89

- What does our ABG tell us?
- What could we do to help this patient?

CASE STUDY

- Mrs. Dobins is found pulseless and not breathing this morning. After a couple minutes of CPR she has a pulse of 50 bpm and starts breathing on her own but remains unresponsive with no gag reflex. A blood gas is obtained and results are:
- pH = 6.89
- C02 = 70
- p02 = 42
- HC03 = 13
- Sa02 = 50%

- What does our ABG tell us?
- What interventions would be appropriate for Mrs. Dobins?

CASE STUDY

- You find Mr. Simmons to be in respiratory distress. He was admitted with shortness of breath and productive cough X1 week and has been diagnosed with pneumonia. He has a history of Type-I diabetes mellitus and his blood glucose is 583 and he is now febrile. His ABG shows:
- pH = 7.00
- C02 = 59
- p02 = 86
- HC03 = 14
- Sa02 = 91%

- What does our ABG tell us?
- What interventions would be appropriate for Mr. Simmons?