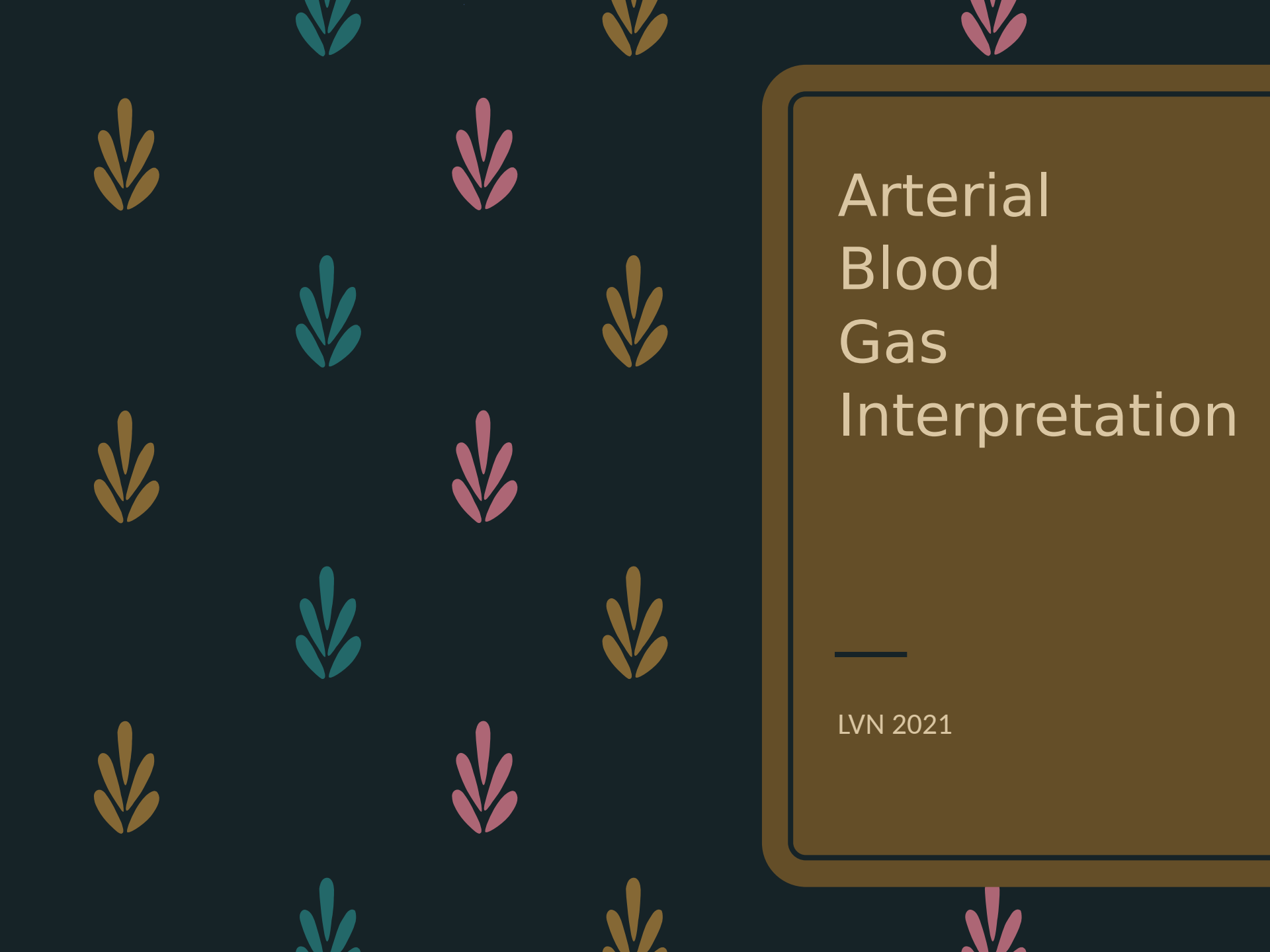




Arterial Blood Gas Interpretation

LVN 2021

Learning outcomes

- Interpret arterial blood gas (ABG) values
- Implement nursing interventions accordingly



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?

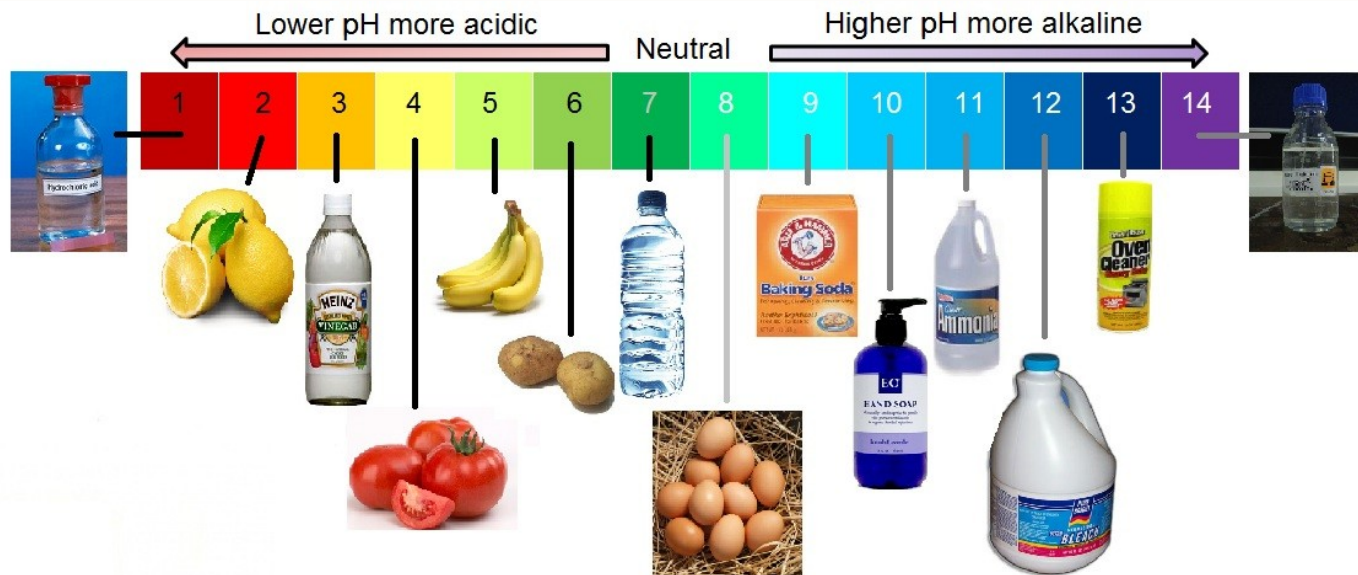
Lab	Value
pH	7.35-7.45
PaO ₂	80-100 mm Hg
SaO ₂	>95%
PaCO ₂	35-45 mm Hg
HCO ₃ ⁻	22-26 mEq/L (mmol/L)

Glossary of terms used in ABG analysis

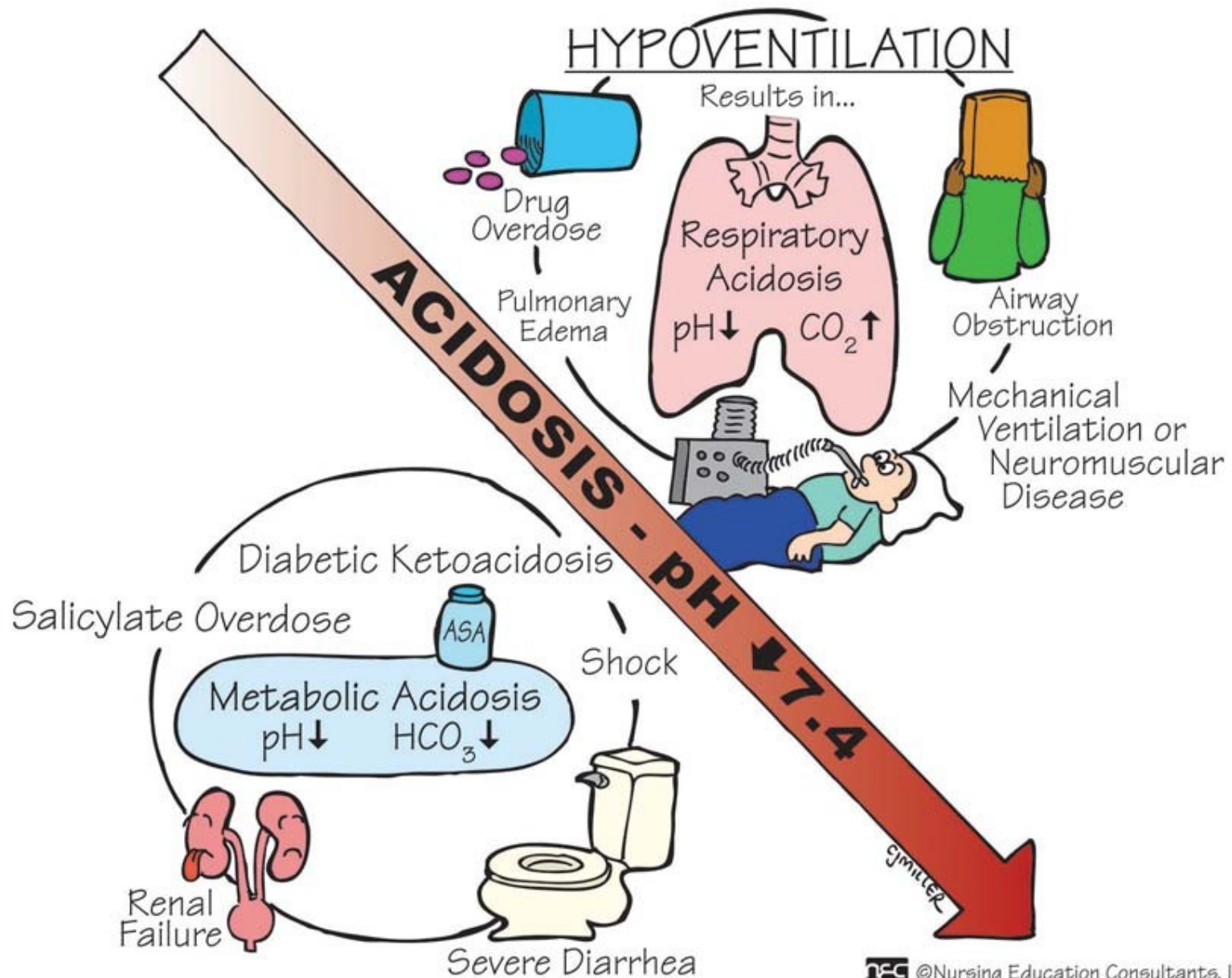
- pH - Acid content of the blood
- PaCO₂ - Carbon dioxide content of the blood
- PaO₂ - Oxygen content of the blood
- HCO₃ - Bicarbonate content of the blood
- SaO₂ - Percentage of hemoglobin saturated with oxygen
- Hypoxia - Inadequate oxygenation of the tissue
- Hypoxemia - Low oxygen content in the blood
- Hypercarbia - High carbon dioxide content
- Acidemia - Too much acid in the blood
- Alkalemia - Too many buffers in the blood
- Compensation - Ability of the body to stabilize acid-base imbalances

Let's talk Ph

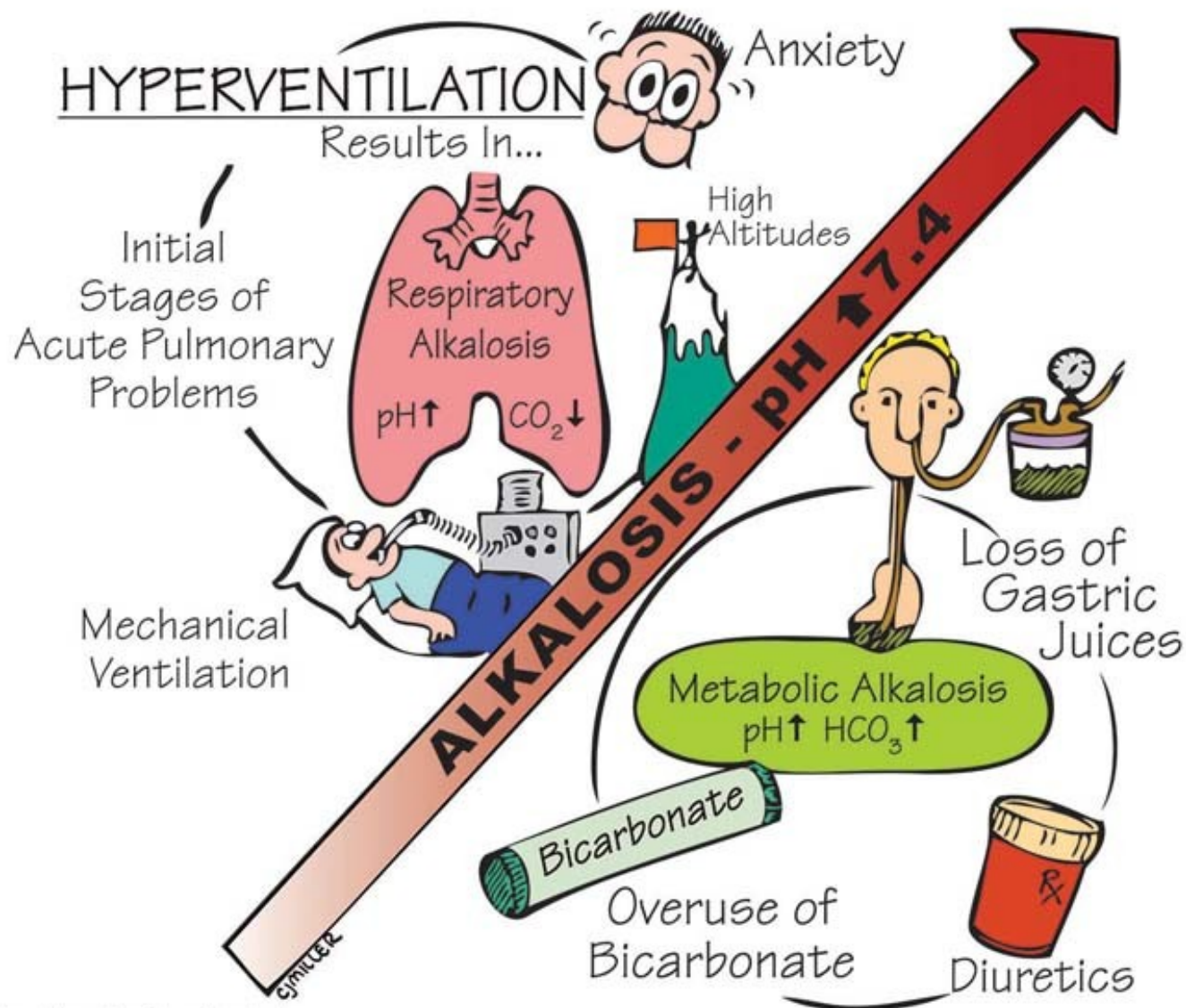
- 7 is neutral
- >7 is alkaline = **Alkalosis**
- <7 is acid = **Acidosis**



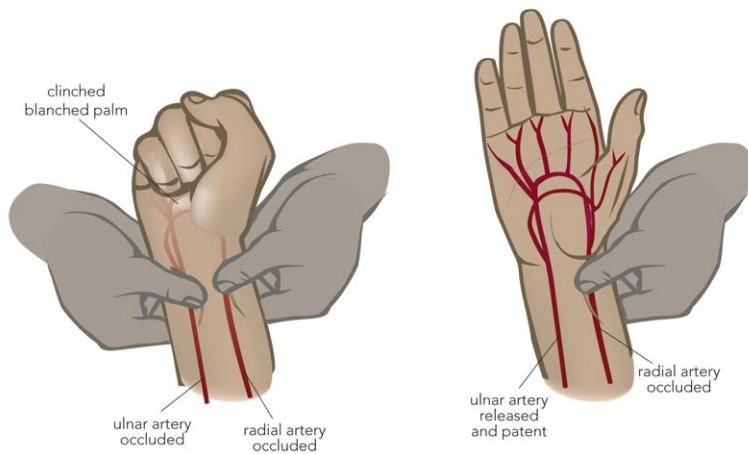
CAUSES OF ACIDOSIS



CAUSES OF ALKALOSIS



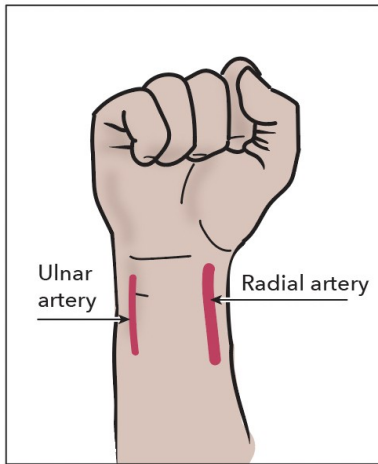
Assessing Circulation using the Allen Test pre ABG



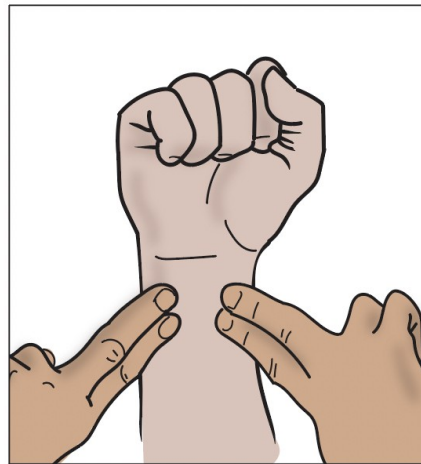
- Compress the radial and ulnar artery while having patient make a fist
- Relax hand and watch for blanching
- Release ulnar artery and watch for flushing
- Indicates patency of ulnar artery and ability to use radial for ABG

The Modified Allen Test

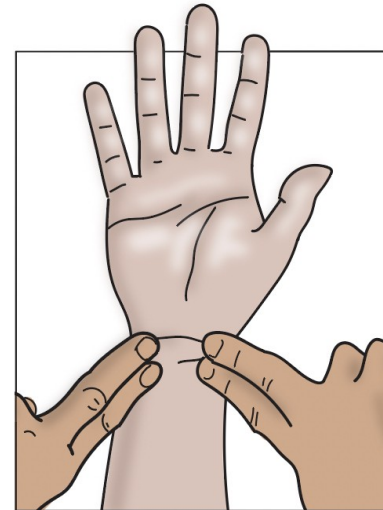
This test is used to check the overall blood supply to the hand.



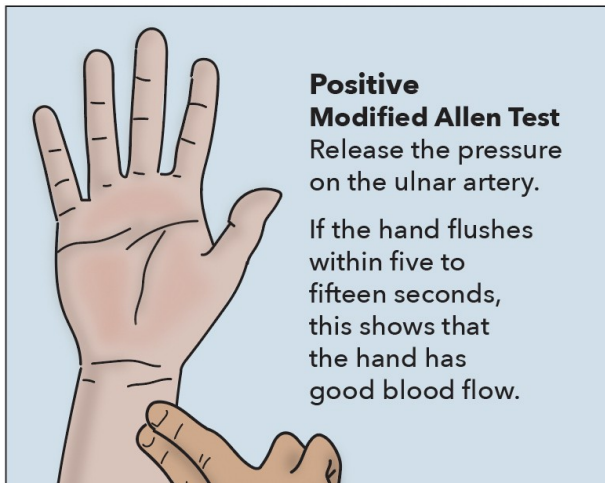
Locate the ulnar and radial arteries. Have the patient make a tight fist for about thirty seconds.



To obstruct blood flow, press down on the ulnar artery with two fingers. At the same time, press down on the radial artery.



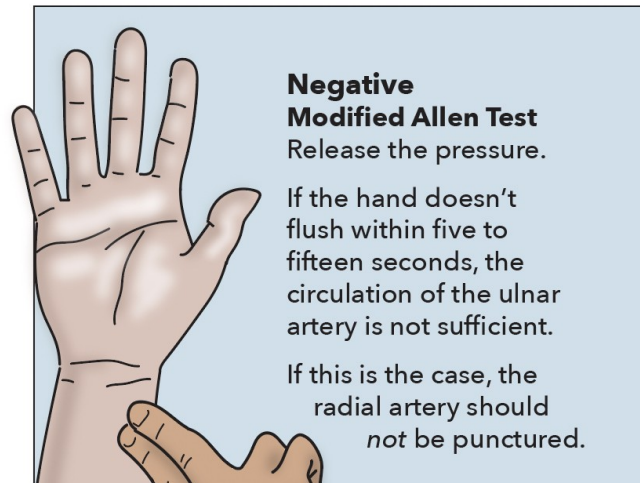
Tell the patient to unclench; their palm should blanch. If it doesn't, you are not applying enough pressure -- start again.



Positive Modified Allen Test

Release the pressure on the ulnar artery.

If the hand flushes within five to fifteen seconds, this shows that the hand has good blood flow.



Negative Modified Allen Test

Release the pressure.

If the hand doesn't flush within five to fifteen seconds, the circulation of the ulnar artery is not sufficient.

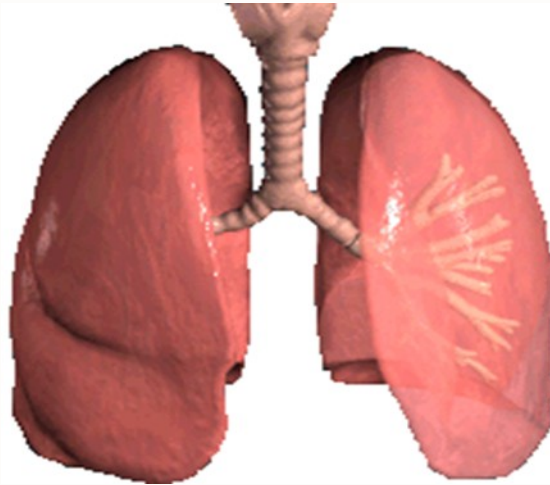
If this is the case, the radial artery should *not* be punctured.

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 HCO_3^- (**base**) levels
- Slower system, takes hours to days

**To
Compensate
for
Acidosis**

*** H^+ ions
will be
excreted &
 HCO_3^- will
be retained**



**To
Compensate
for
Alkalosis**

*** H^+ ions
will be
retained &
 HCO_3^- will
be
excreted**

Steps to abg analysis

- **Step 1:** Determine if patient 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

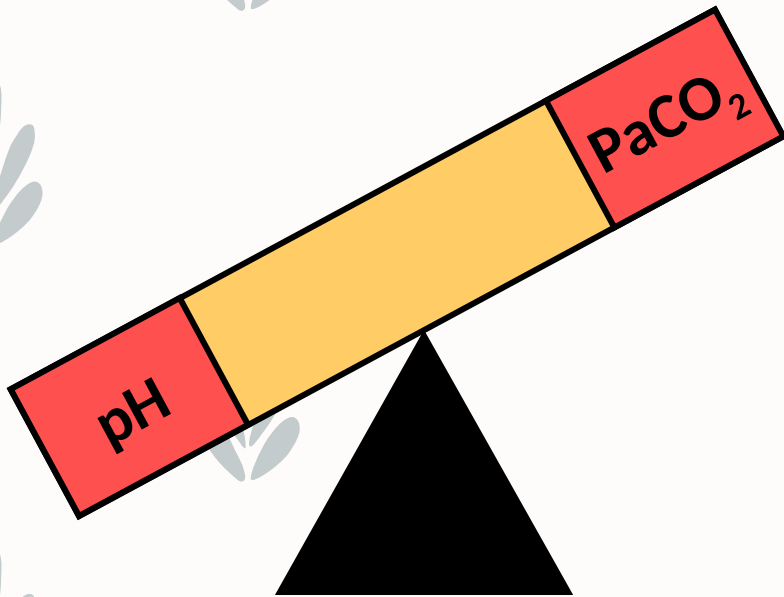
pH		
< 7.35	7.35 – 7.45	> 7.45
Acidosis	Normal or Compensated	Alkalosis

Step 2: Analyze PaCO₂ to Determine Respiratory Effect

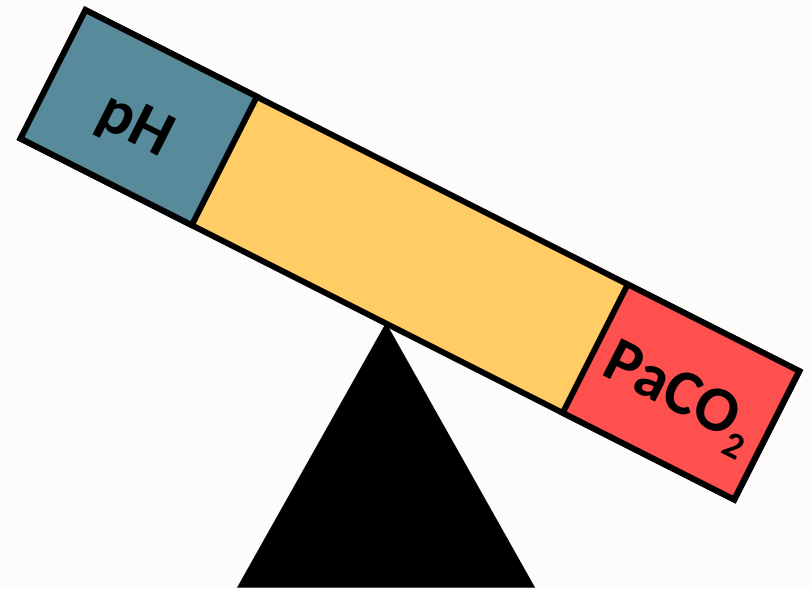
PaCO ₂		
< 35	35 - 45	> 45
Trends Toward Alkalosis	Normal or Compensated	Trends Towards Acidosis

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)

I can't catch my breath.

- Drowsiness, Dizziness, Disorientation

- Muscle Weakness, Hyperreflexia

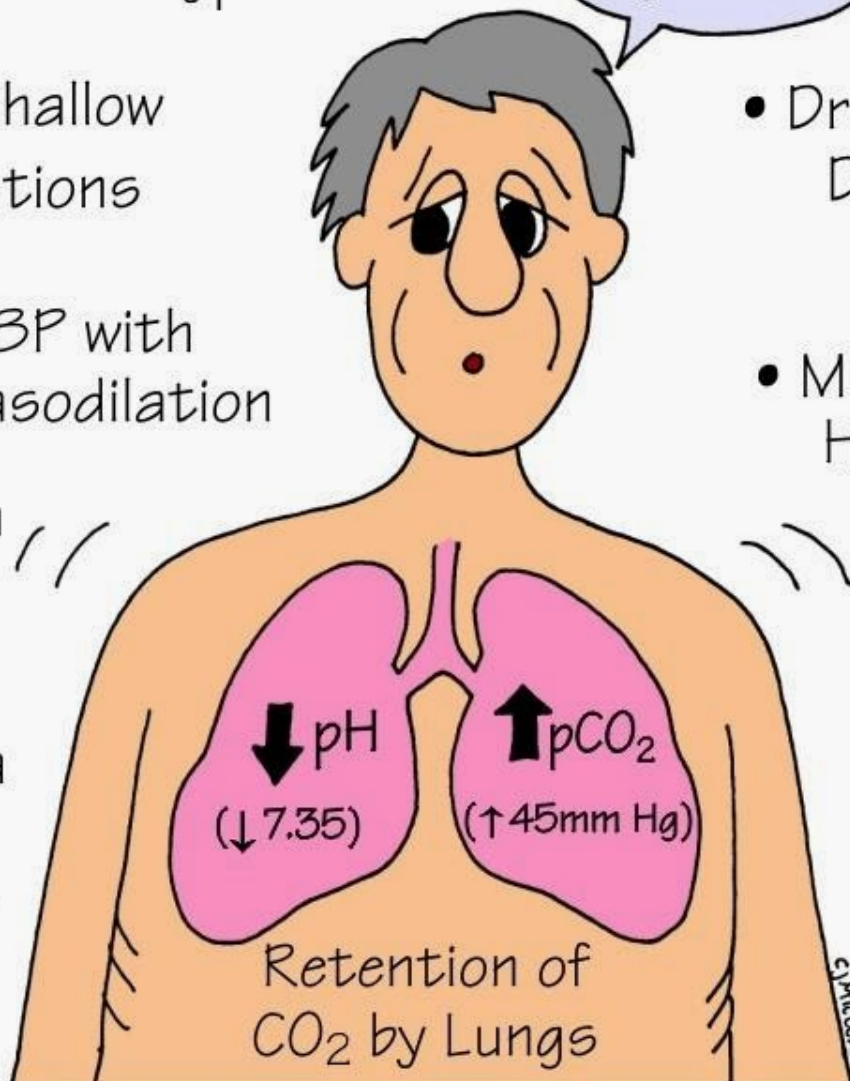
- Causes:

- ↓ Respiratory Stimuli (Anesthesia, Drug Overdose)

COPD

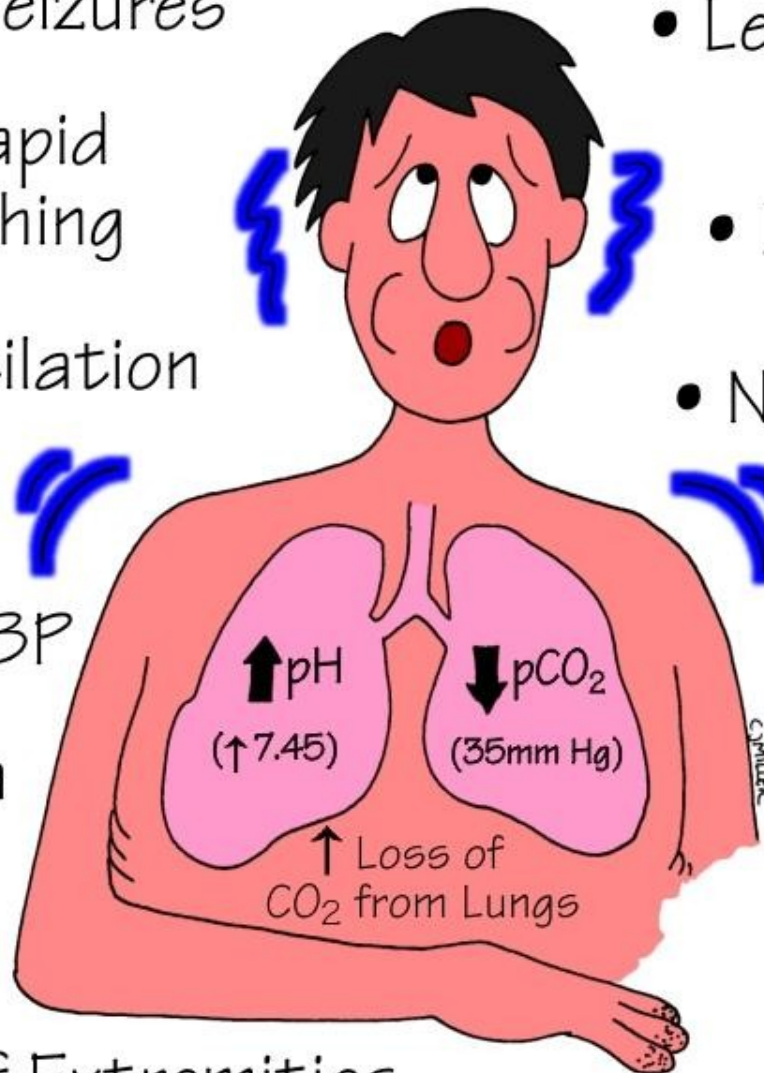
Pneumonia

Atelectasis



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

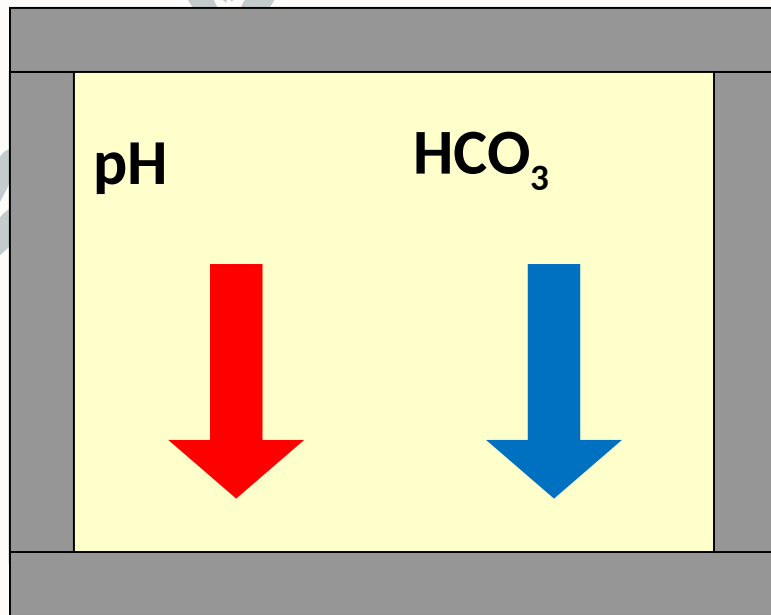


Step 3: Analyze HCO_3^- to Determine Metabolic Effect

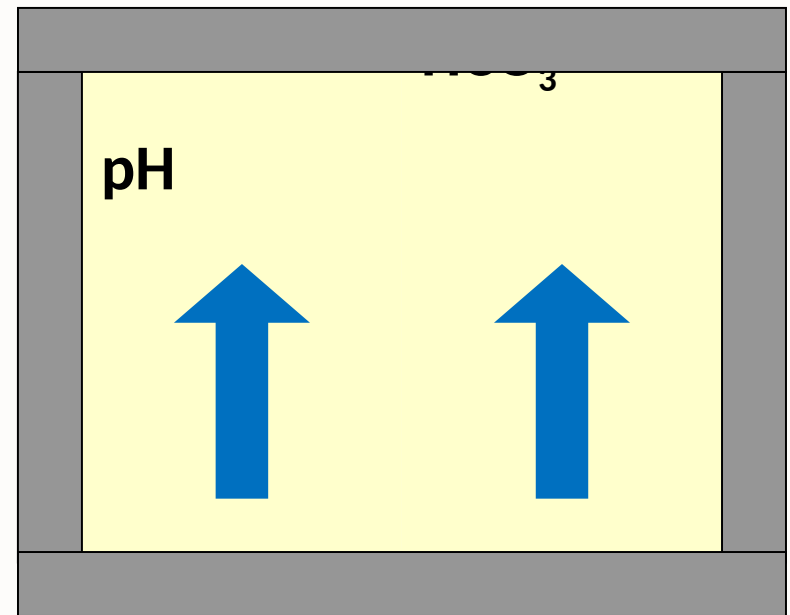
HCO_3^-		
< 22	22 - 26	> 26
Trends Towards Acidosis	Normal or Compensated	Trends Towards Alkalosis

METABOLIC EFFECTS

- The “Elevator” Effect



Metabolic **Acidosis**



Metabolic **Alkalosis**

METABOLIC ACIDOSIS

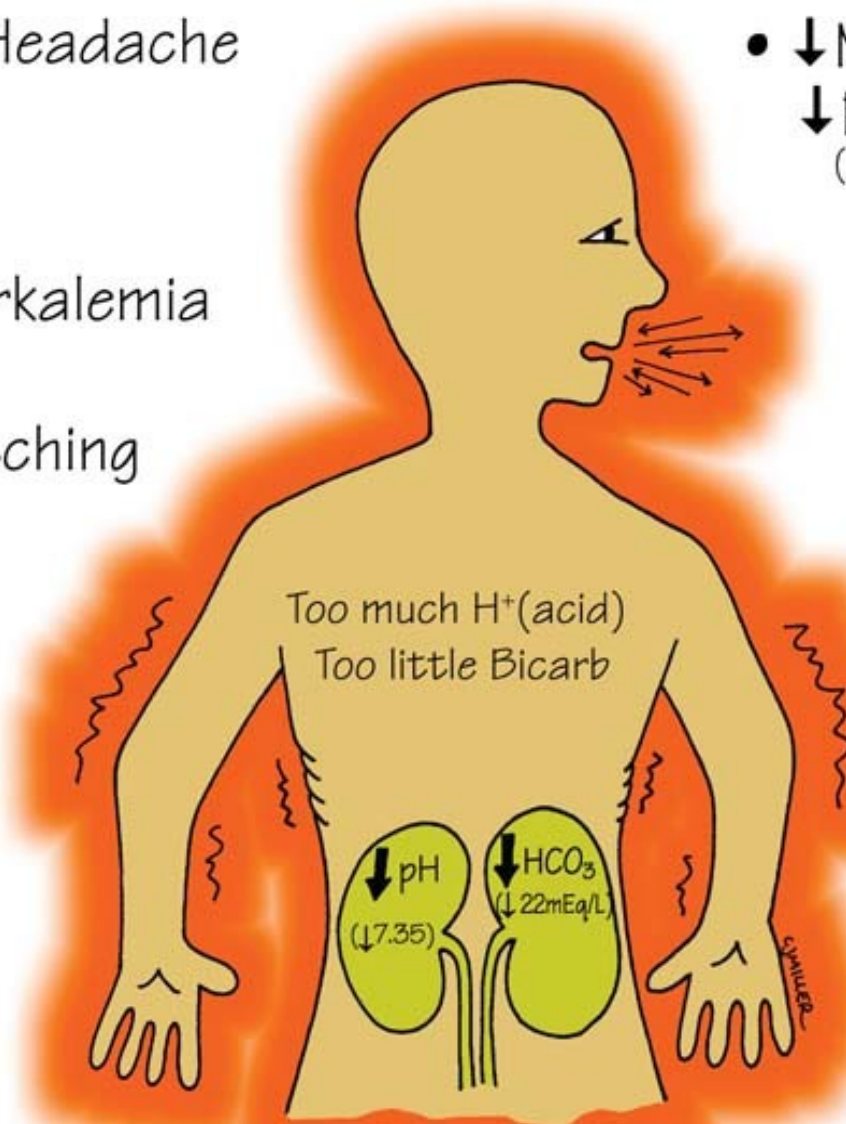
- Headache
- ↓BP
- Hyperkalemia

- ↓Muscle Tone,
↓Reflexes
(Confusion, ↑Drowsiness)

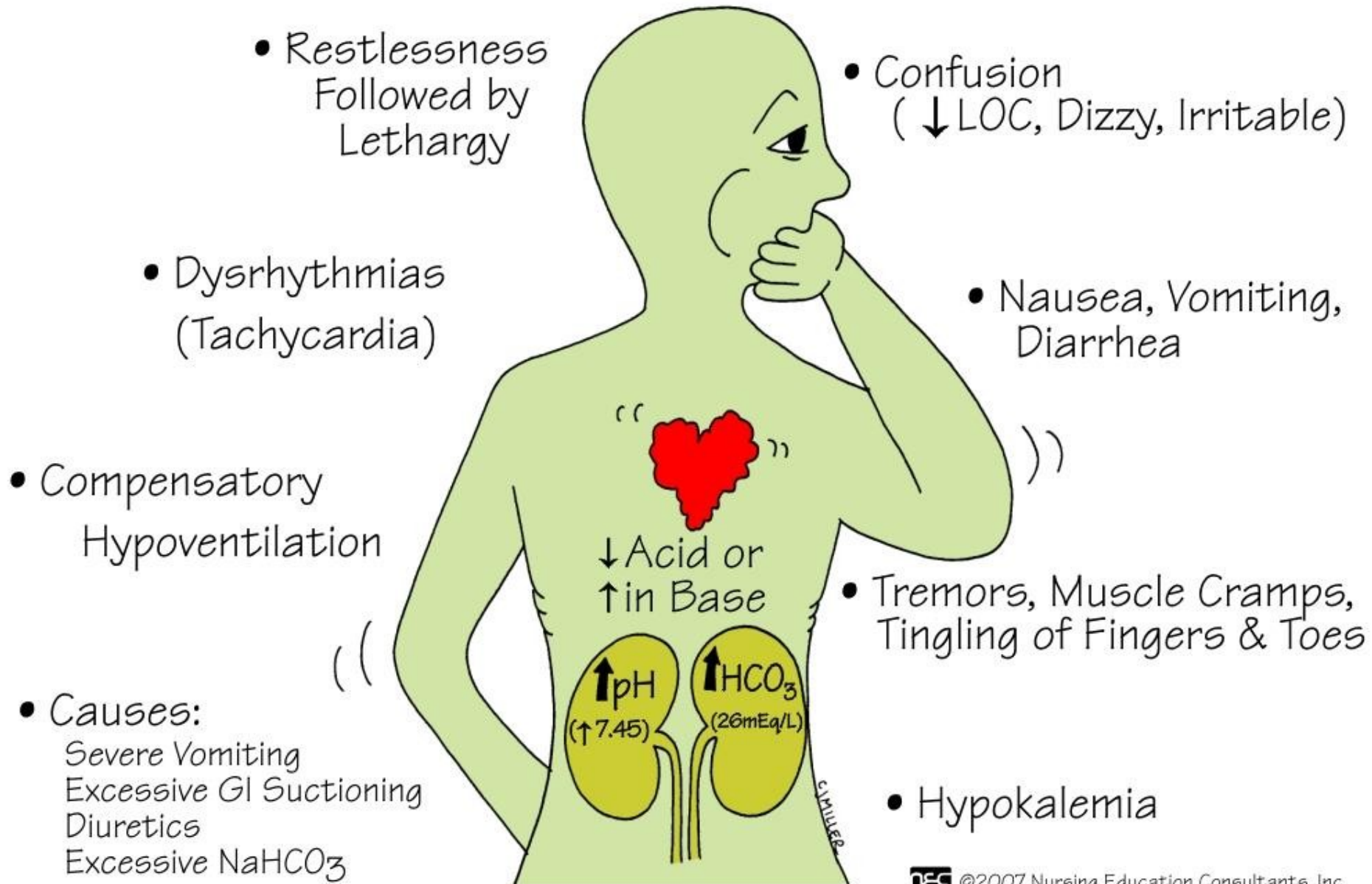
- Kussmaul
Respirations
(Compensatory
Hyperventilation)

- Causes:
 - ↑H⁺ Production
(DKA, hypermetabolism)
 - ↓H⁺ Elimination
(renal failure)
 - ↓HCO₃ Production
(dehydration, liver failure)
 - ↑HCO₃ Elimination
(diarrhea, fistulas)

- Muscle Twitching
- Warm,
Flushed
Skin
(Vasodilation)
- Nausea,
Vomiting



METABOLIC ALKALOSIS



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!

A	N	B
p H		
HCO 3		CO ₂

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 (PaCO ₂)	Metabolic (HCO ₃ ⁻) *SLOW: 5-7 days
Metabolic (HCO ₃ ⁻)	Respiratory (PaCO ₂) *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*

A	N	B
p		
H		
HCO	CO ₂	
3		

*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)

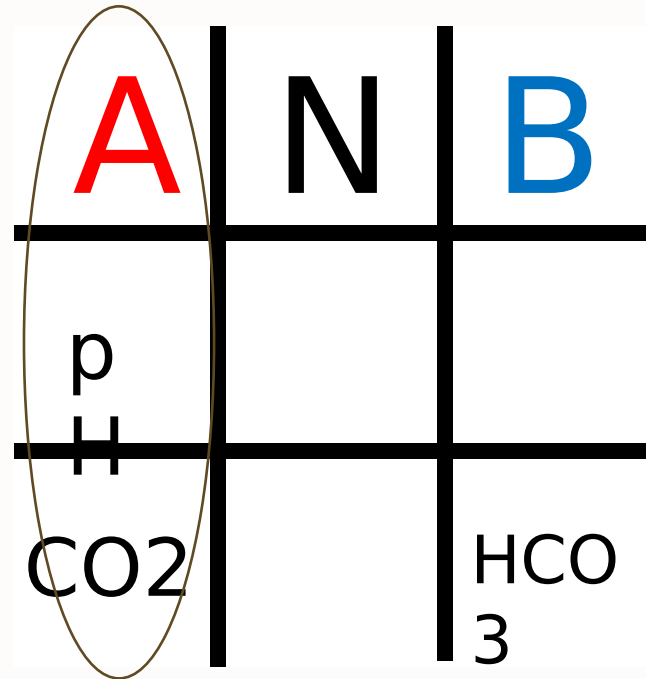
- Respiratory Acidosis

- 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*



A	N	B
pH		
CO ₂		HCO ₃

*Partially compensated
respiratory acidosis

Extent of compensation

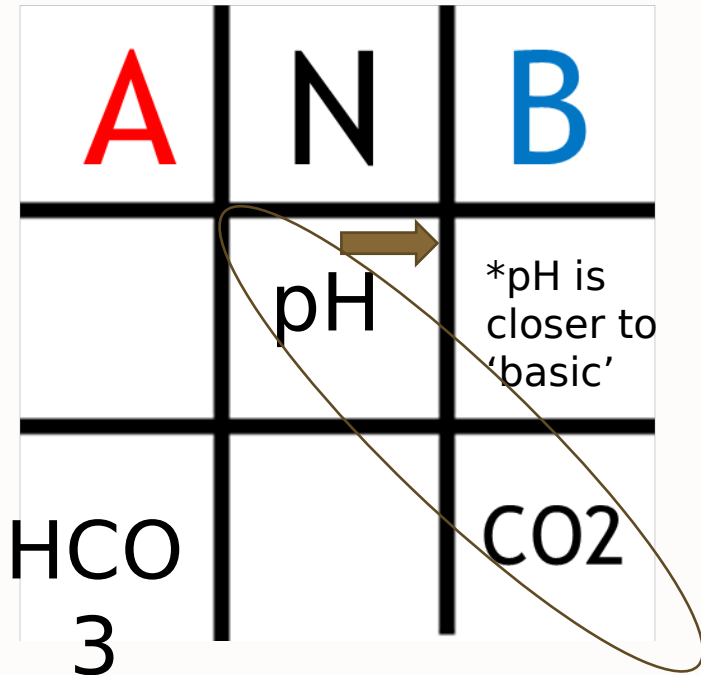
- Full:

- 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.

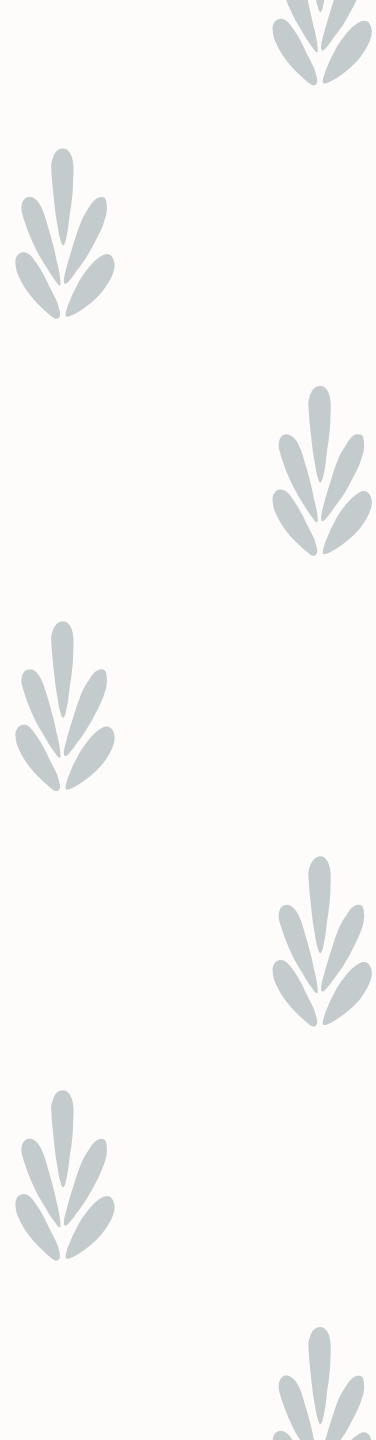
- pH – 7.44 (N)(B)
- PaCO₂ – 30 (B)
- HCO₃ – 21 (A)
- Respiratory Alkalosis
- Full Compensation
 - HCO₃⁻ is abnormal, BUT the pH is normal.

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

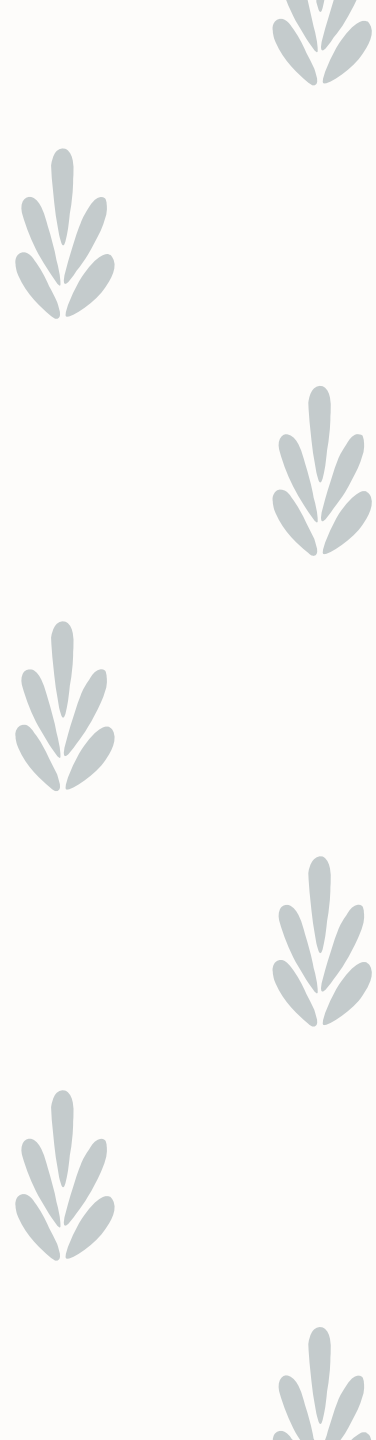
The slide features several decorative leaf icons in a light blue-grey color, arranged vertically along the left margin. There are five such icons, each consisting of three stylized leaves pointing upwards.

Step 5

- Determine oxygenation status
 - Evaluate $pO_2 = 80-100$ mm Hg
 - *Is it normal?*
 - *What is the client's baseline?*
 - *Is it an acceptable range for this client?*
 - Evaluate $SaO_2 = 95-100\%$
 - *Is it normal?*
 - Evaluate Hemoglobin (Hgb)
 - *female 12-16 g/dl; male 14-18 g/dl*
 - *Are there enough oxygen carriers?*

Step 5: con't

Normal Pao2	80-100 mmHg
Mild Hypoxemia	70-80 mmHg
Moderate Hypoxemia	60-70 mmHg
Severe Hypoxemia	<60 mmHg

The slide features a vertical column of seven stylized leaf icons on the left side. Each icon is composed of three leaf-like shapes pointing upwards, rendered in a light blue-grey color. The main title is positioned to the right of these icons.

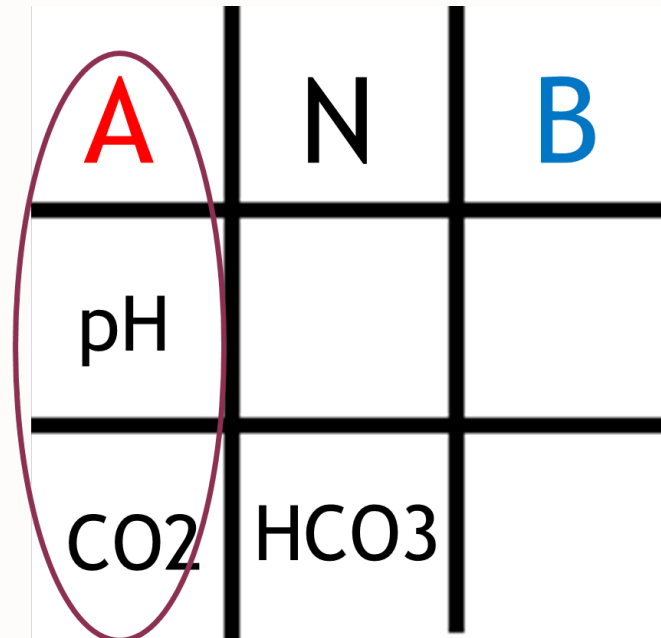
Evaluate client to place blood gas analysis in proper context

- Does client's clinical picture match the acid-base and oxygen interpretation?
- Does the client have a chronic disorder that is associated with long-term alterations in ABGs?
- Are there any acute processes occurring that need to be taken into consideration?
- Does the client have fever?

Practice

- 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



A	N	B
pH		
CO ₂	HCO ₃	

- Uncompensated **Respiratory Acidosis** with Moderate Hypoxemia

Practice

- A 28 year-old is being prepared for a craniotomy. The patient is very anxious and scared of the impending surgery. He begins to hyperventilate and becomes very dizzy. The patient loses consciousness and STAT ABG's reveal:

- pH = 7.57
- PaCO₂ = 26 mmHg
- HCO₃ = 24 mEq/L
- PaO₂ = 59 mmHg

A	N	B
		pH
	HCO ₃	CO ₂

- Uncompensated Respiratory Alkalosis with Severe 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

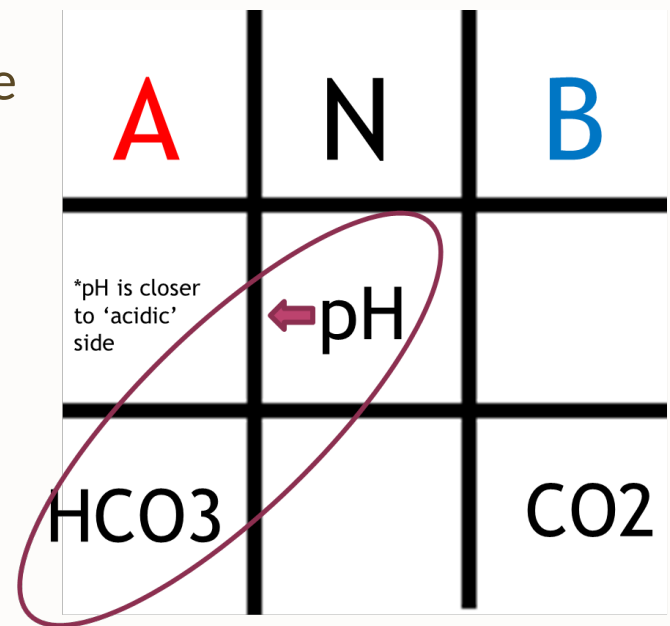
A	N	B
		pH
CO ₂		HCO ₃

- Partially Compensated **Metabolic Alkalosis** with Severe Hypoxemia

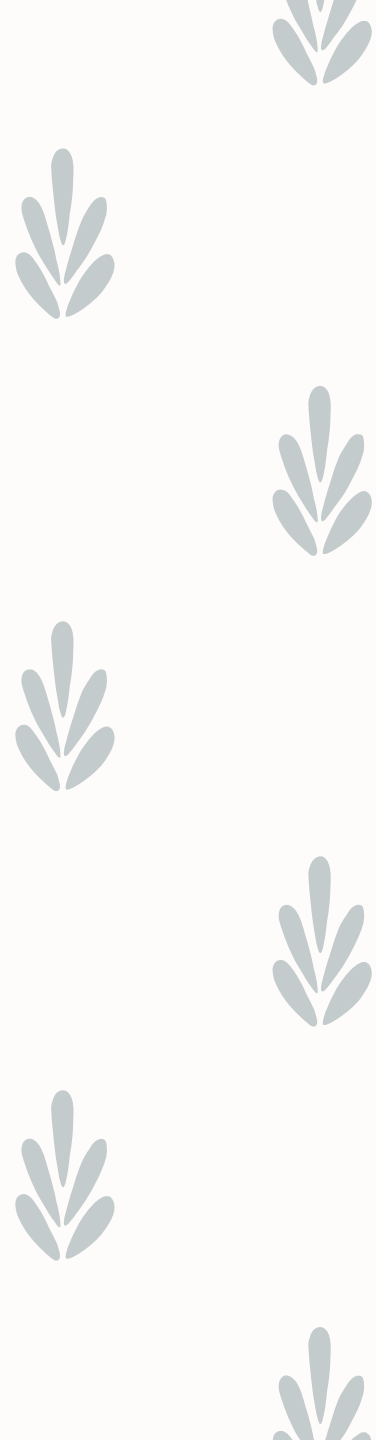
Practice

– 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 : 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

The slide features five decorative leaf icons arranged vertically on the left side. Each icon is a stylized, light blue leaf with a central vein and two side veins, pointing upwards.

Another way to evaluate using ROME Pneumonic

- R respiratory
- O opposite
- M metabolic
- E equal

Pneumonic (cont.)

-
- | | | |
|--------------------|-------------|-----------|
| - pH | 7.48↑ B | 7.35-7.45 |
| - CO ₂ | 35 (normal) | 35-45 |
| - HCO ₃ | 30↑ B | 22-26 |
- Both arrows are moving in same direction so it's a metabolic imbalance
 - Metabolic Alkalosis no compensation
 - Arrows moving in same direction (metabolic equal)

Pneumonic (cont.)

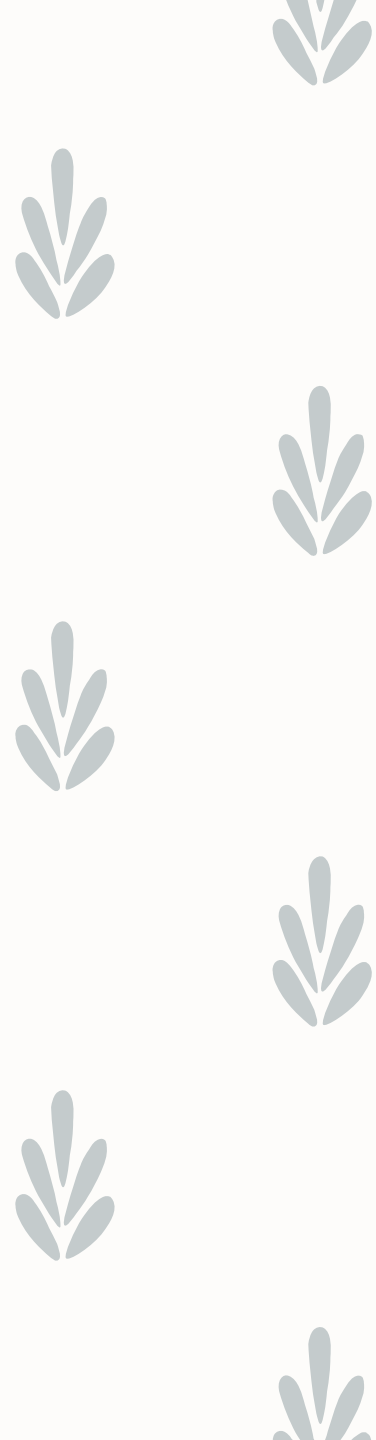
- pH 7.32↓ A

- CO₂ 55↑ A

- HCO₃ 30↑ B

- CO₂ matches pH so Resp. Acisosis with partial compensation

- Arrows are moving in opposite direction pH ↓ & CO₂ ↑ (resp. opposite)



Mixed Acid Base Imbalance

- pH 7.35 A ↓

- CO₂ 30 A ↑

- HCO₃ 15 A ↓

- **RULE:** when CO₂ or HCO₃ value is:

- In a direction opposite to its predicted direction
- Not close to the predicted value during normal compensatory activity

