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?

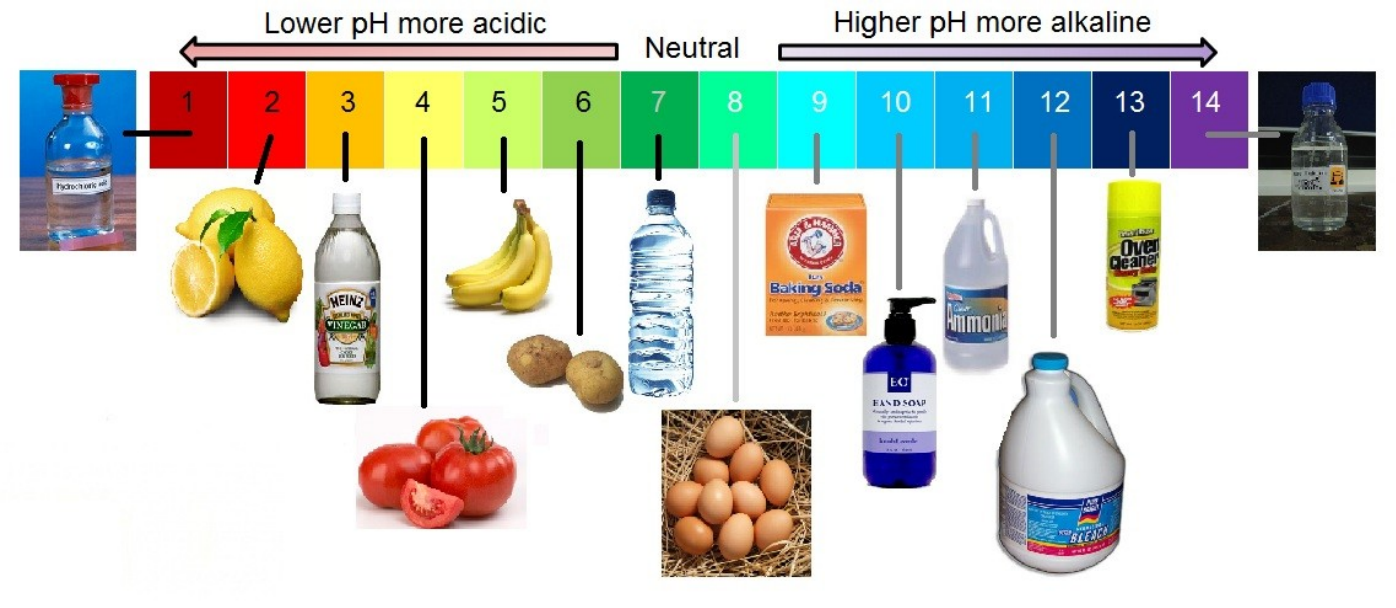
Lab	Value
pH	7.35-7.45
PaO2	80-100 mm Hg
SaO2	>95%
PaCO2	35-45 mm Hg
HCO3-	22-26 mEq/L (mmol/L)

Glossary of terms used in ABG analysis

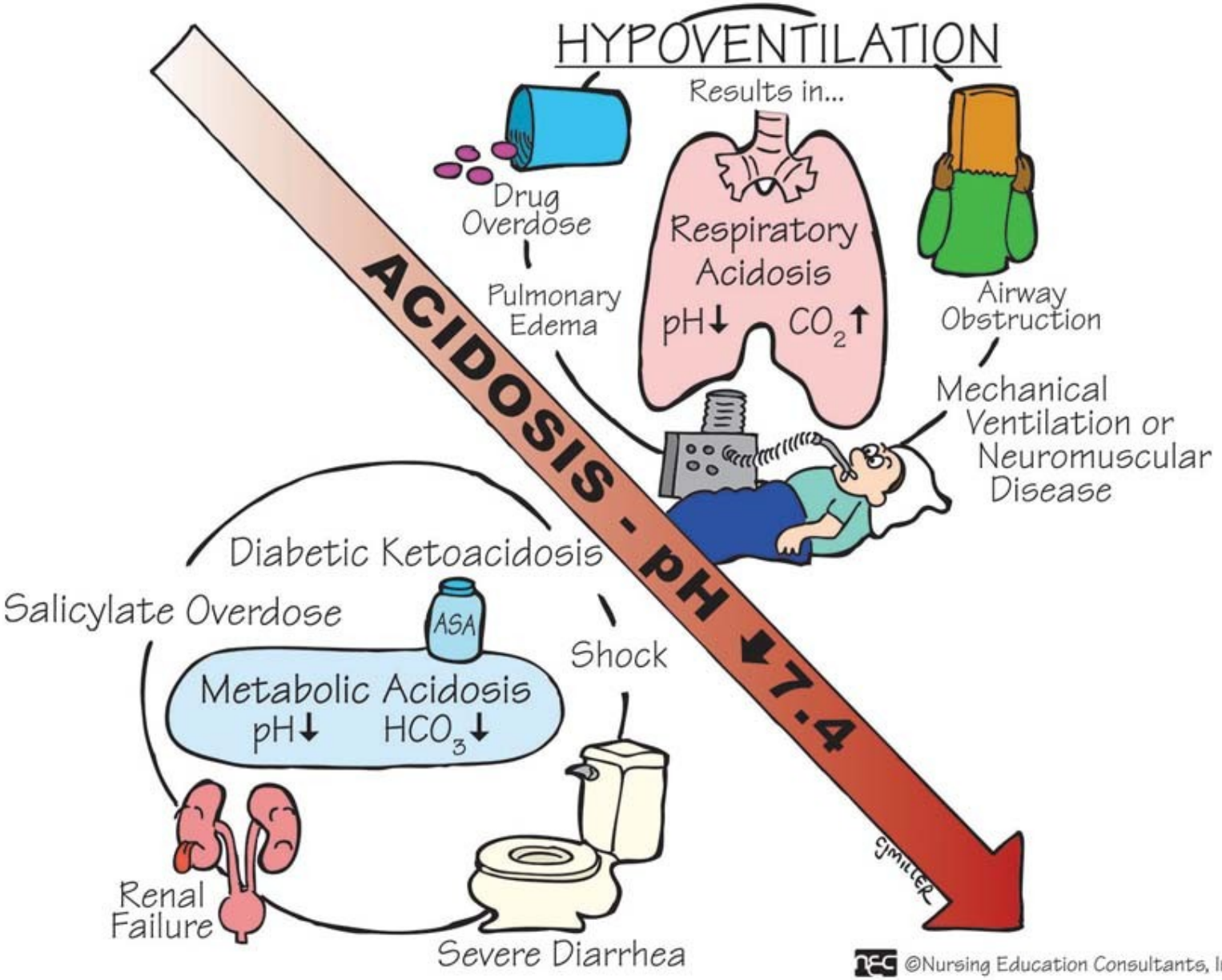
- pH - Acid content of the blood
- $PaCO_2$ - Carbon dioxide content of the blood
- PaO_2 - Oxygen content of the blood
- HCO_3 - Bicarbonate content of the blood
- SaO_2 - Percentage of hemoglobin saturated with oxygen
- Hypoxia - Inadequate oxygenation of the tissue
- Hypoxemia - Low oxygen content 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

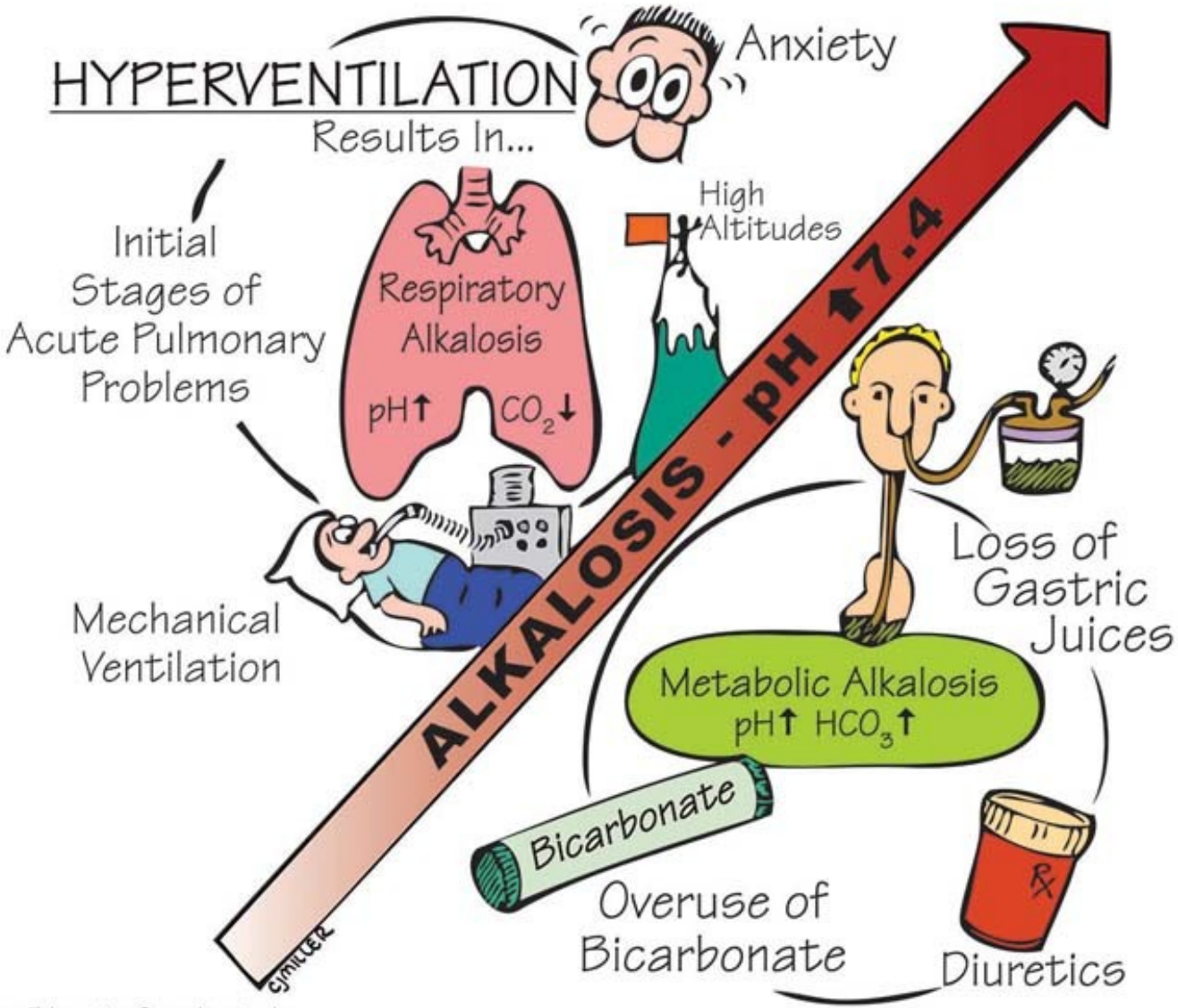
- 7 is neutral
- >7 is alkaline = Alkalosis
- <7 is acid = Acidosis



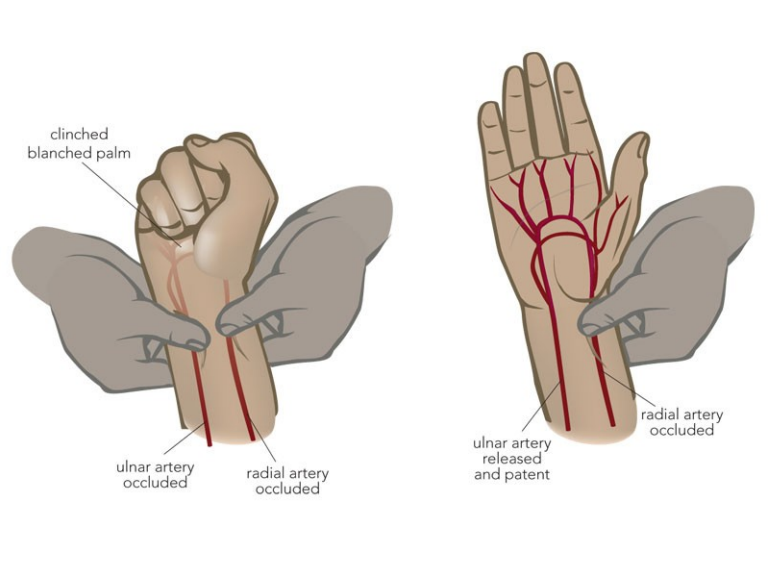
CAUSES OF ACIDOSIS



CAUSES OF ALKALOSIS



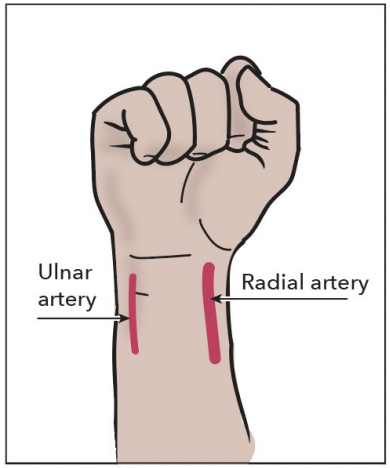
Assessing Circulation using the Allen Test pre ABG



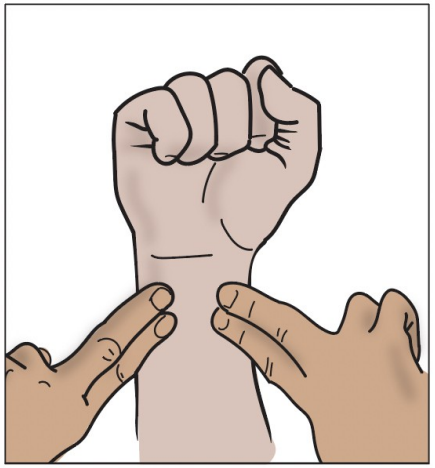
- Compress the radial and ulnar artery while having patient make a fist
- Relax hand and watch for blanching
- Release ulnar artery and watch for flushing
- Indicates patency of ulnar artery and ability to use radial for ABG

The Modified Allen Test

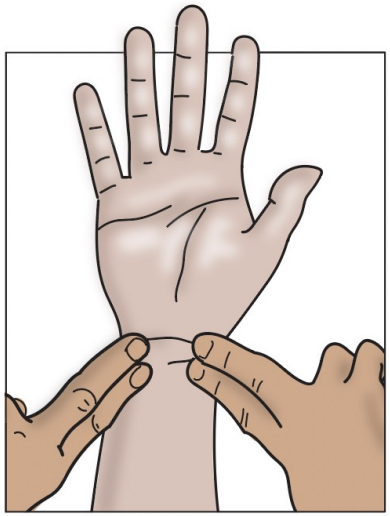
This test is used to check the overall blood supply to the hand.



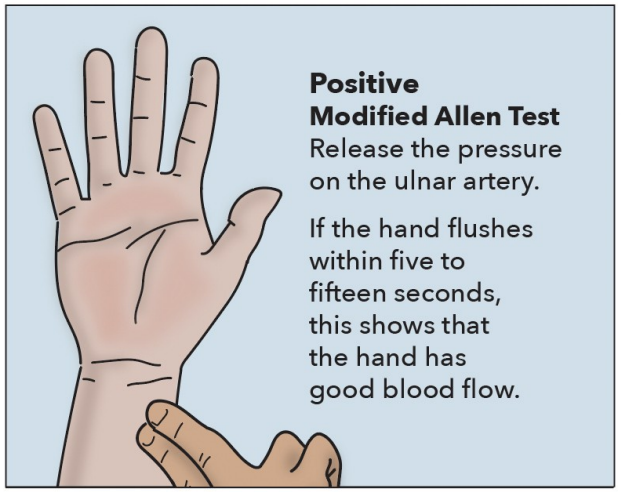
Locate the ulnar and radial arteries. Have the patient make a tight fist for about thirty seconds.



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

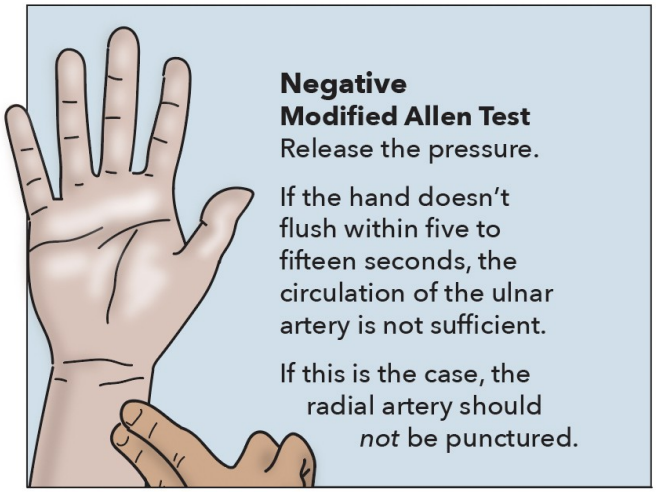


Tell the patient to unclench; their palm should blanch. If it doesn't, you are not applying enough pressure -- start again.



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.



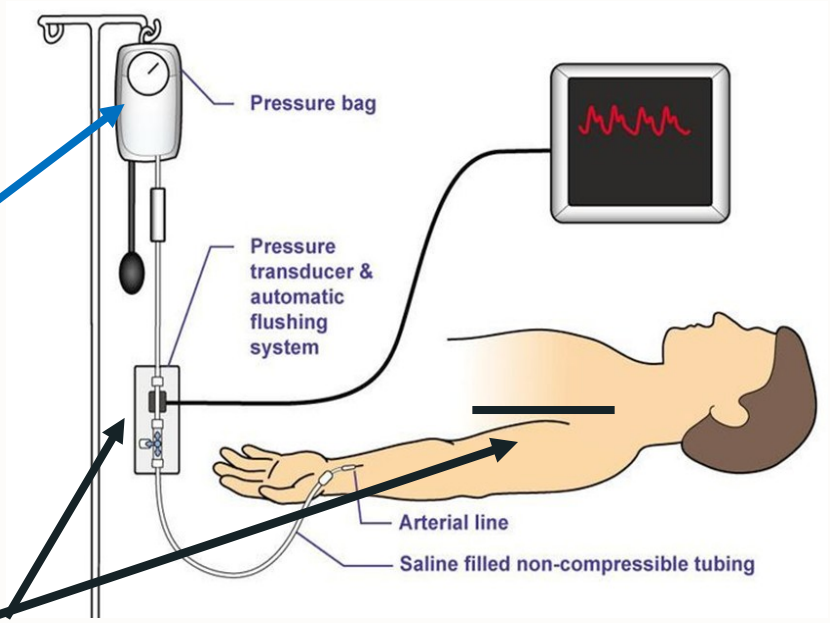
Negative Modified Allen Test
Release the pressure.

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

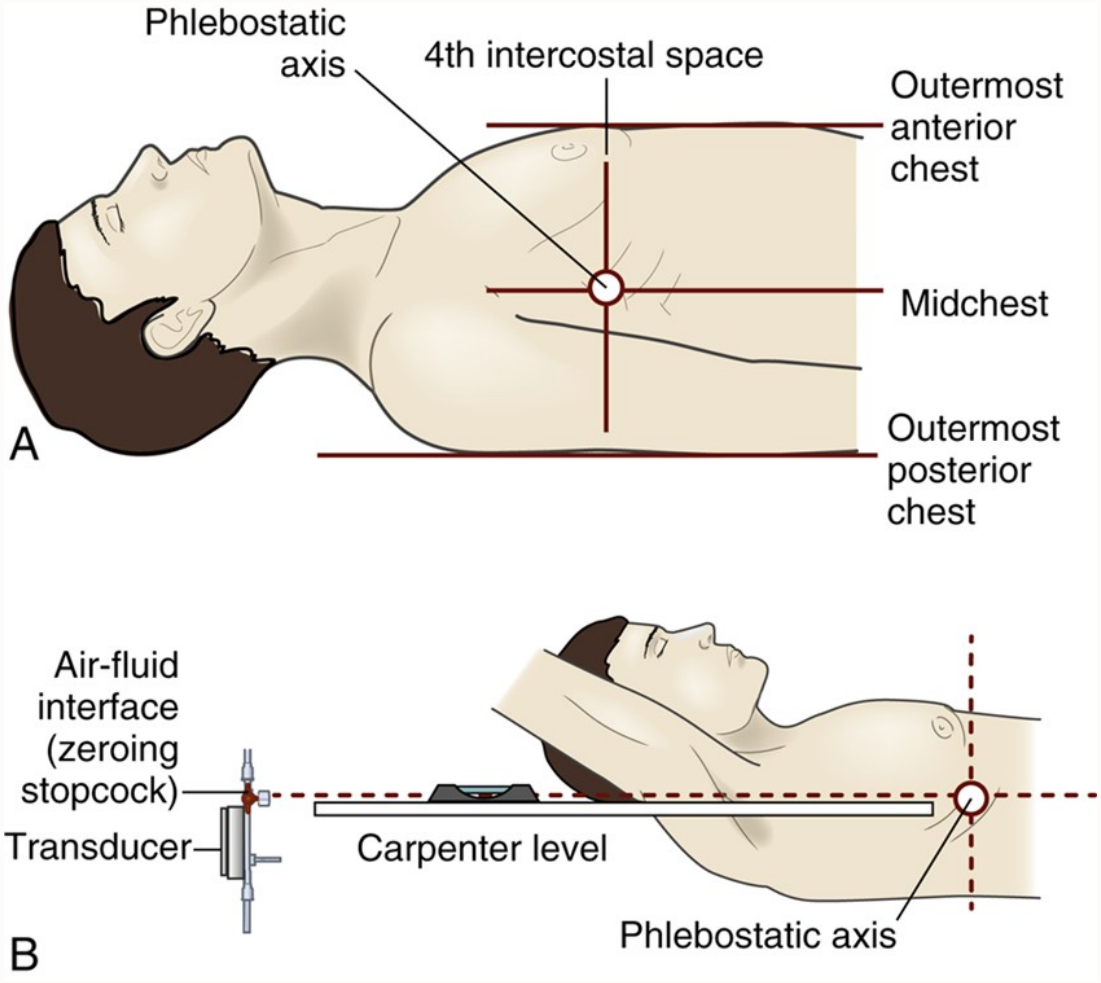
If this is the case, the radial artery should *not* be punctured.

Arterial Line and Monitoring

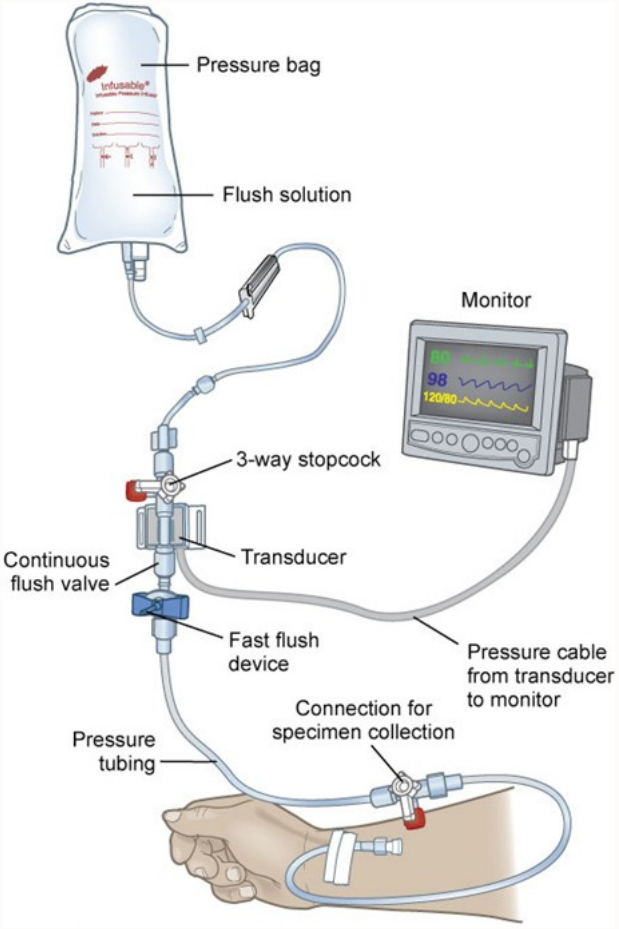
- Placed for continuous vital sign monitoring and frequent blood draws especially ABG's
- Usual Location: Radial or femoral artery



- Safety:
  - 0.9% NS used as fluid for pressurized system
  - NO meds given per arterial line
  - Monitor extremity circulation
  - Pressure system 300 mmHg
  - Transducer level at phlebostatic axis
  - No circumferential dressing/tape


Phlebostatic axis
4th intercostal space
Outermost anterior chest
Midchest
Outermost posterior chest
A
Air-fluid interface (zeroing stopcock)
Transducer
Carpenter level
Phlebostatic axis
B

Arterial Line Pressure System



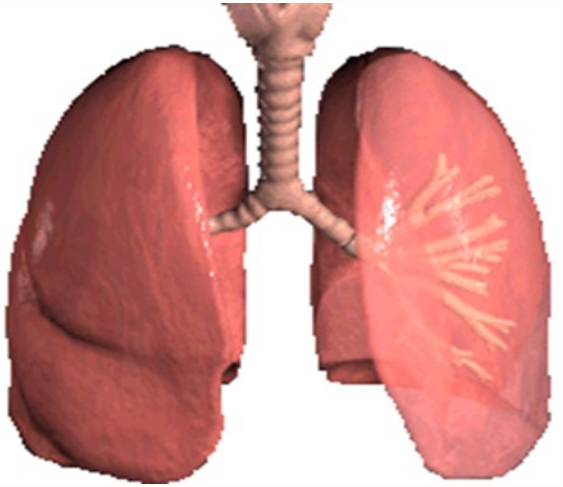
- What nursing interventions/assessments should help identify or prevent complications related to the arterial line?

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 excreted**

Steps to abg analysis

- Step 1: Determine if patient is in Acidosis or Alkalosis using the pH level
- Step 2: Use $PaCO_2$ to determine respiratory effect on the body
- Step 3: Use HCO_3 to determine metabolic effect on the body
- Step 4: Determine compensation

- Step 5: Determine oxygenation range

Step 1: Analyze the Ph = Acidosis or Alkalosis

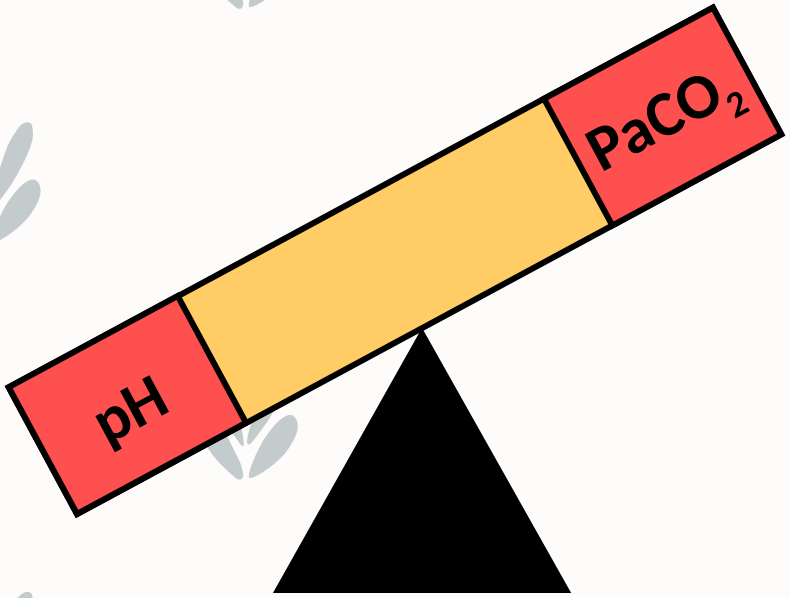
pH		
< 7.35	7.35 – 7.45	> 7.45
Acidosis	Normal or Compensated	Alkalosis

Step 2: Analyze PaCo2 to Determine Respiratory Effect

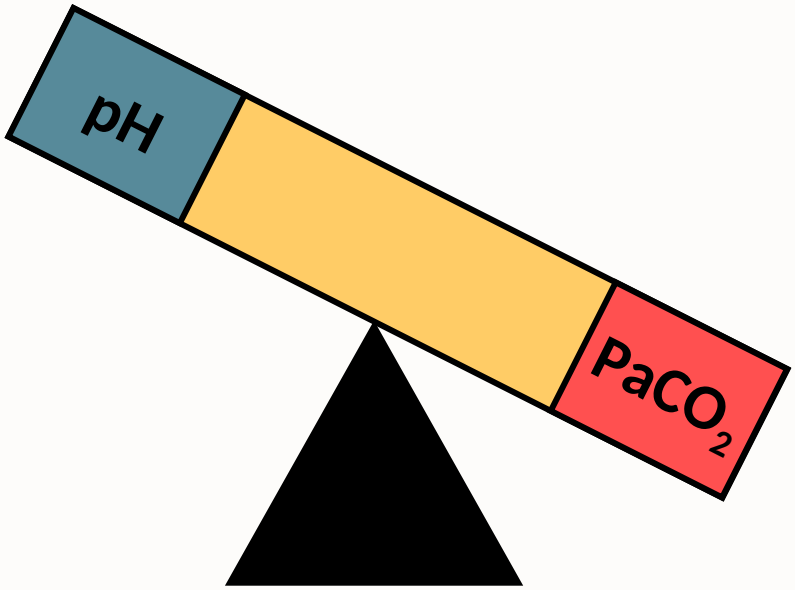
PaCO2		
< 35	35 - 45	> 45
Trends Toward Alkalosis	Normal or Compensated	Trends Towards Acidosis

RESPIRATORY EFFECTS

- The “See-Saw” Effect

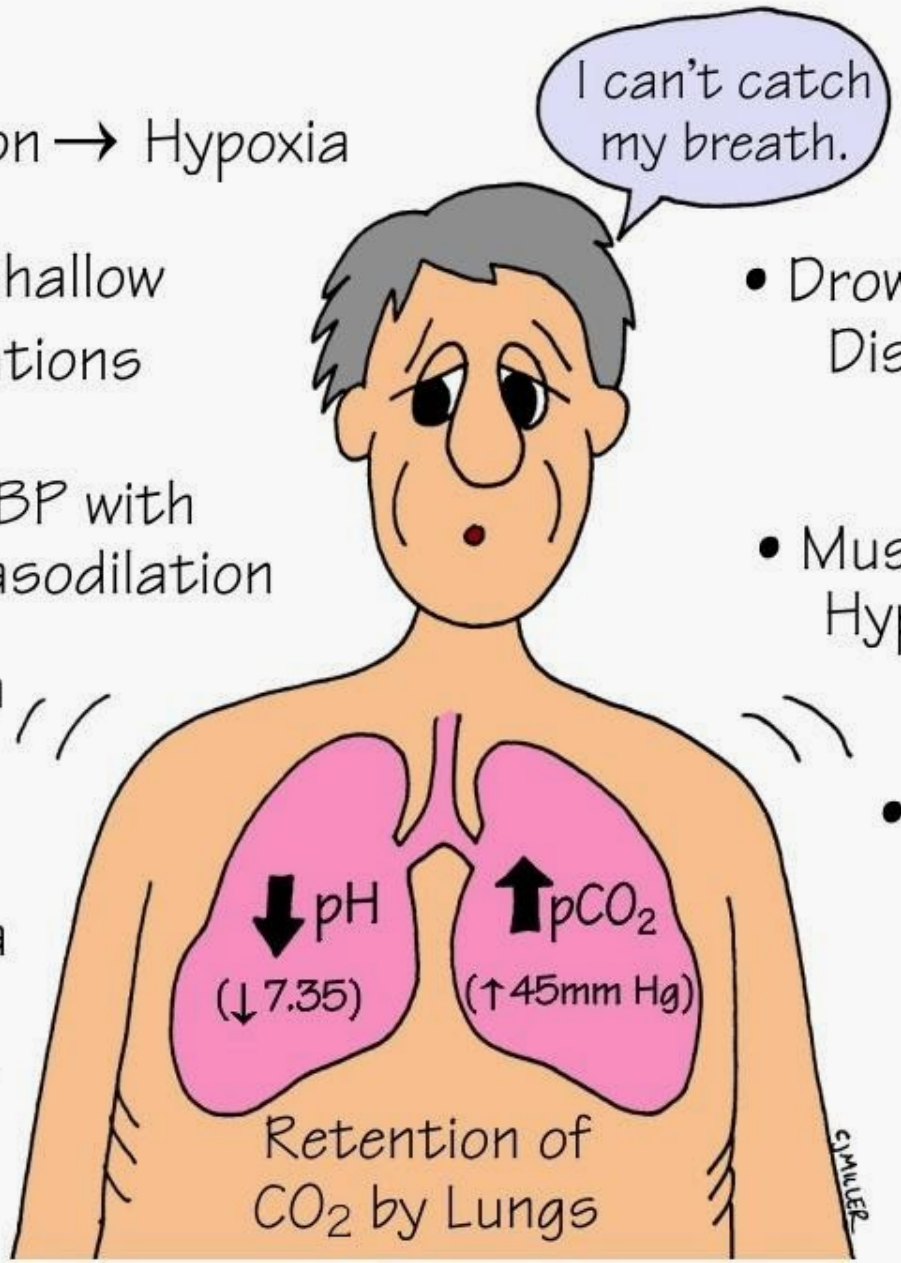


Respiratory Acidosis



Respiratory Alkalosis

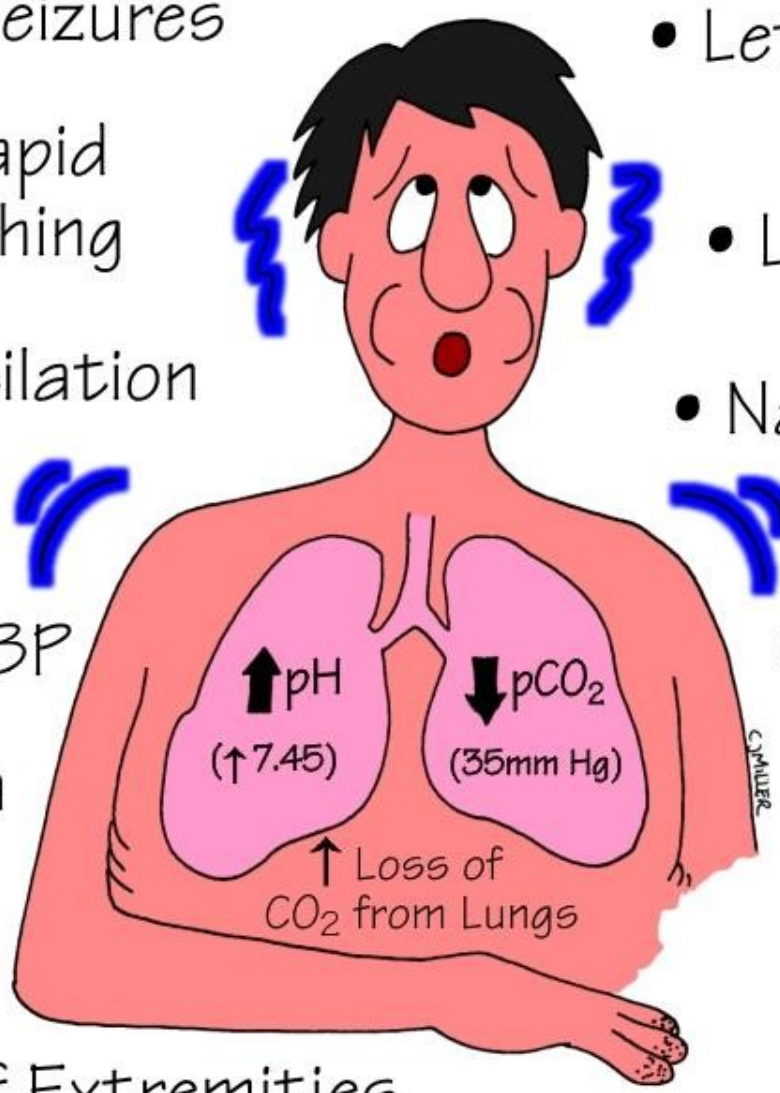
RESPIRATORY ACIDOSIS



- 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



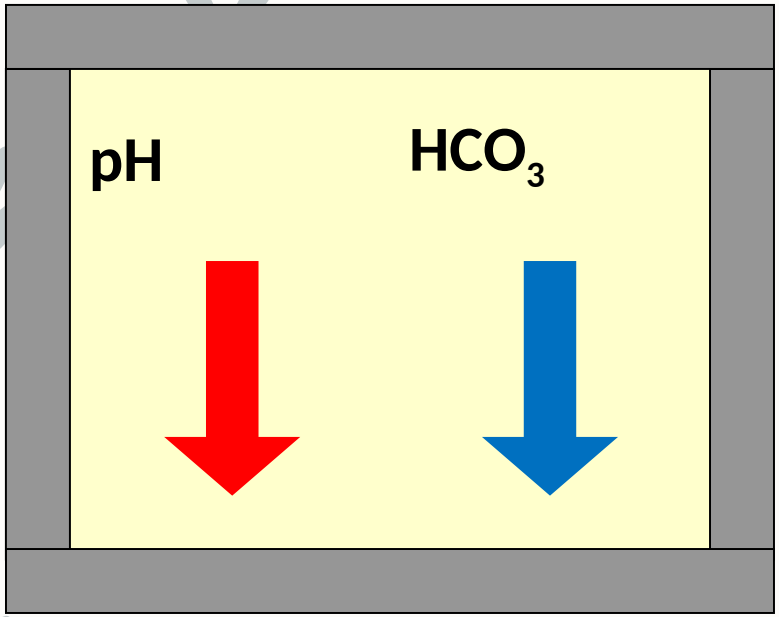
- Lethargy & Confusion
- Light Headedness
- Nausea, Vomiting
- Causes:
  - Hyperventilation
  - (Anxiety, PE, Fear)
  - Mechanical Ventilation

Step 3: Analyze Hco3 to Determine Metabolic Effect

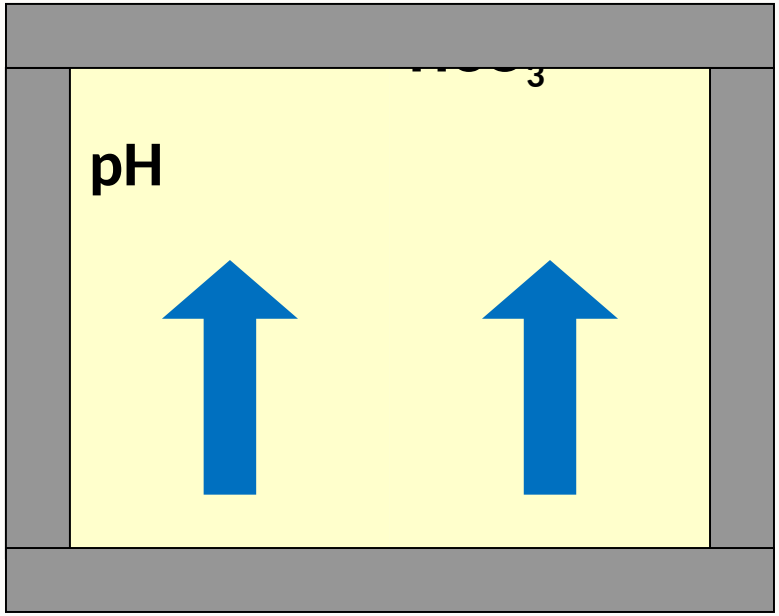
HCO3-		
< 22	22 - 26	> 26
Trends Towards Acidosis	Normal or Compensated	Trends Towards Alkalosis

METABOLIC EFFECTS

- The “Elevator” Effect



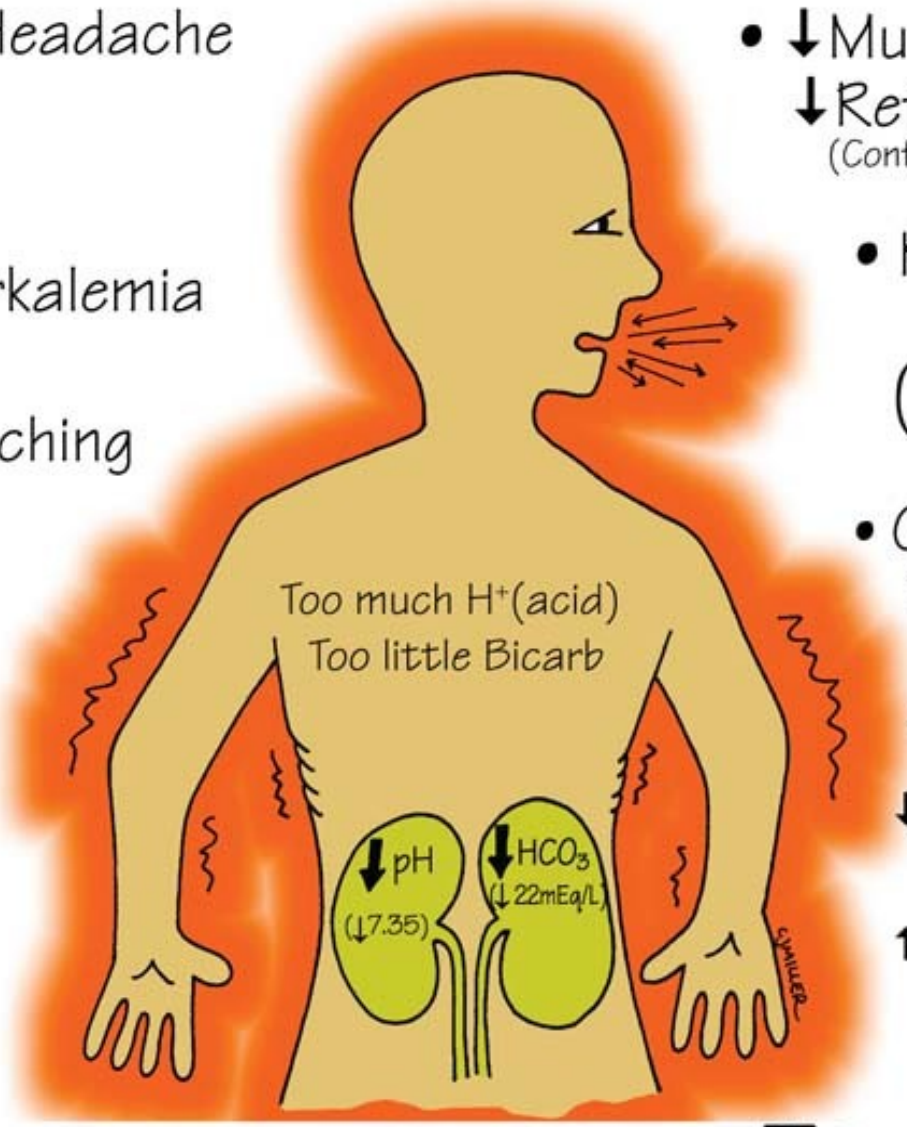
Metabolic Acidosis



Metabolic Alkalosis

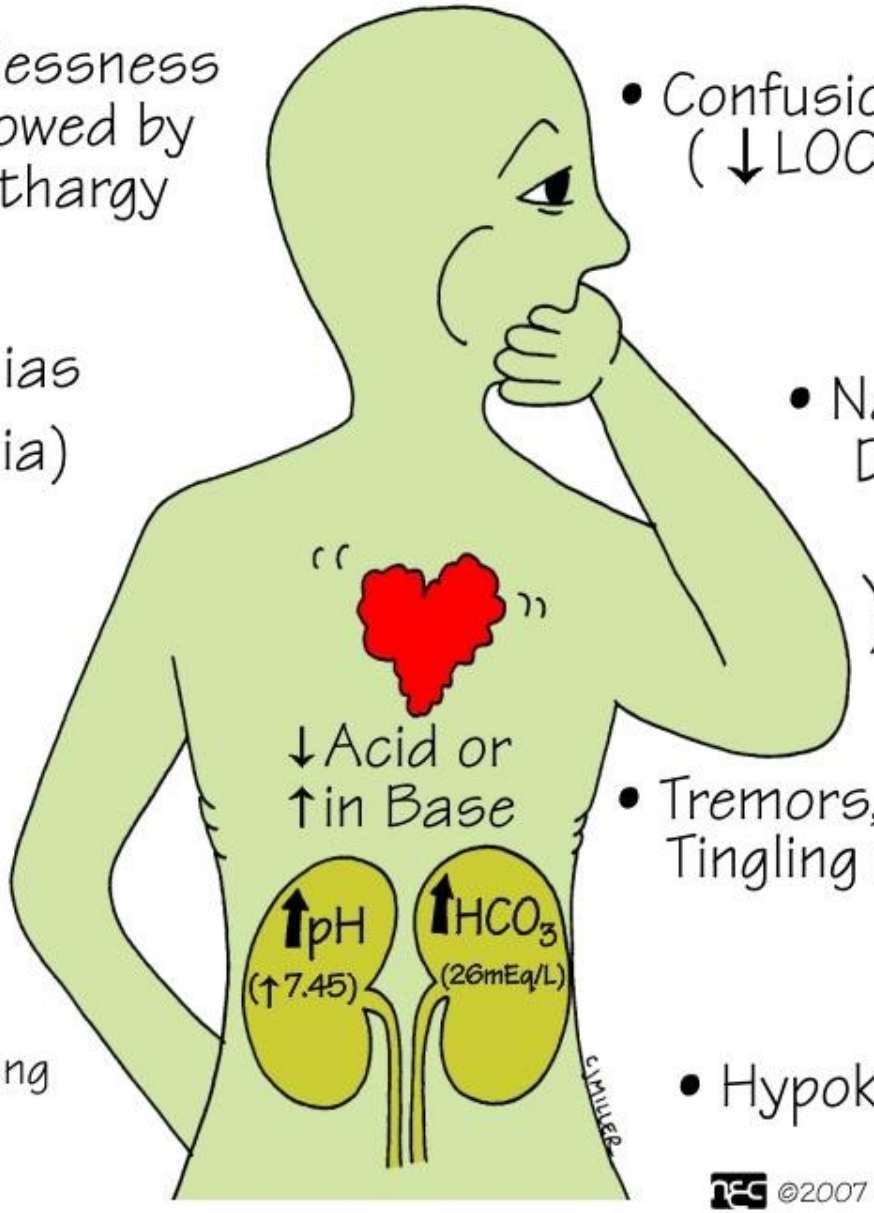
METABOLIC ACIDOSIS

- 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)

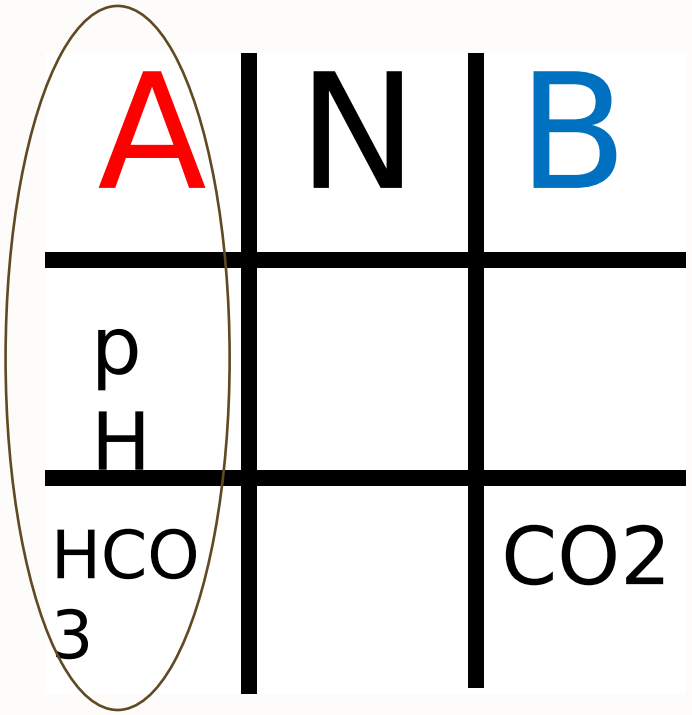
METABOLIC ALKALOSIS



- 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

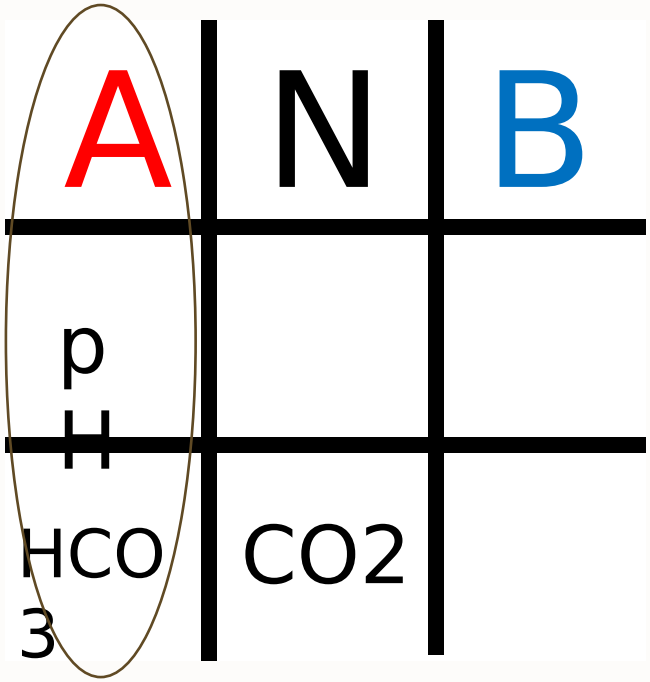
- ABSENT:
  - Which value does not match the pH? (PaCO2 or HCO3)
  - If the value that does **NOT** match pH is **NORMAL**, then **NO** compensation has taken place.

- 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

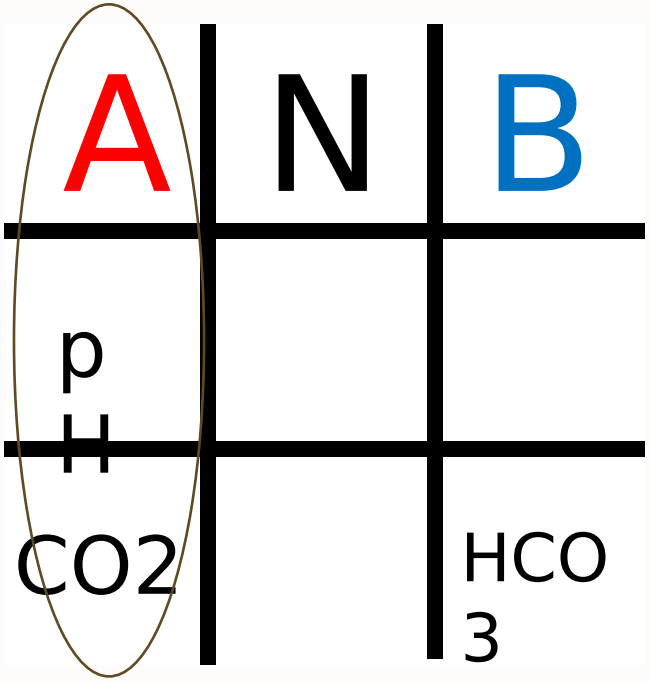
- Partial:
  - Which value does not match the pH? (PaCO2 or HCO3)
  - If the value that does not match pH is **ABNORMAL** & pH is **ABNORMAL**, then **PARTIAL** compensation exists.

- 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

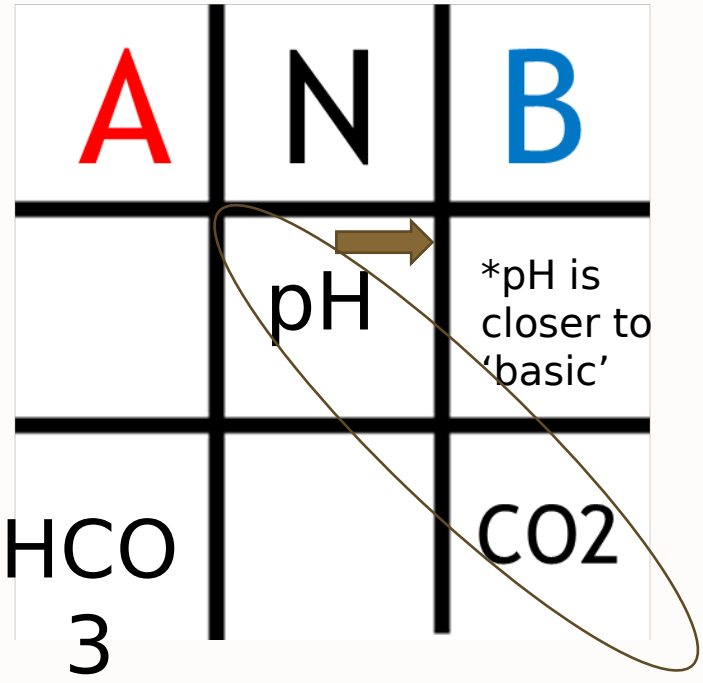
- Full:
  - What value does not match the pH? (PaCO2 or HCO3-)
  - If the value that does **NOT** match the pH is **ABNORMAL** but the pH is **NORMAL**, then **FULL** compensation has taken place.

- 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 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

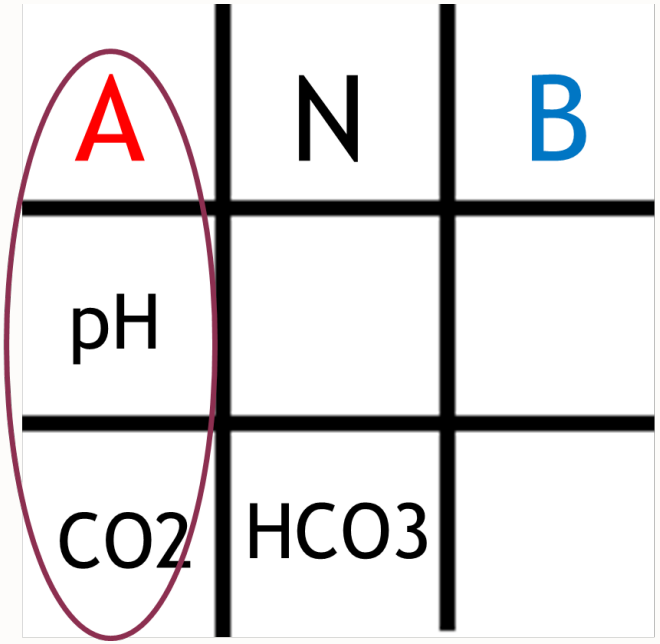
Evaluate client to place blood gas analysis in proper context

- 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

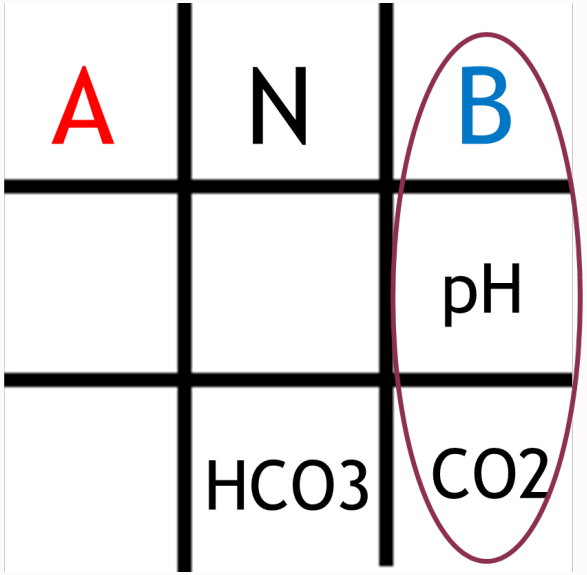


- Uncompensated Respiratory Acidosis with Moderate Hypoxemia

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

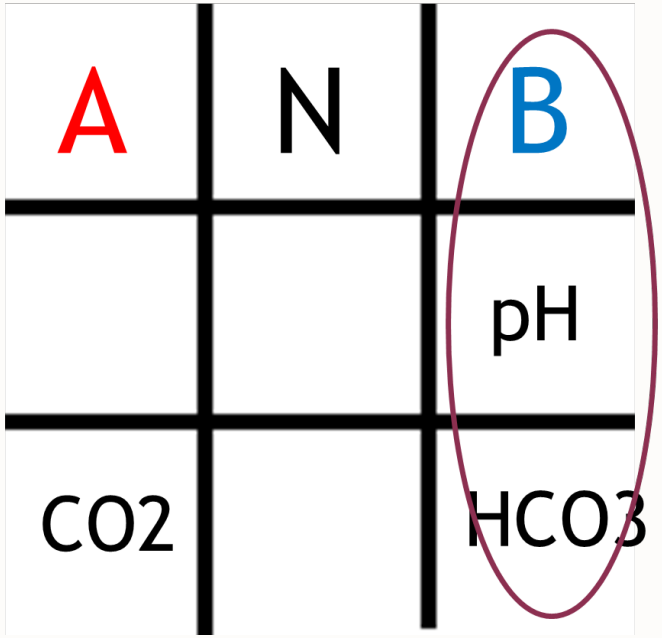


- Uncompensated Respiratory Alkalosis with Severe Hypoxemia

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

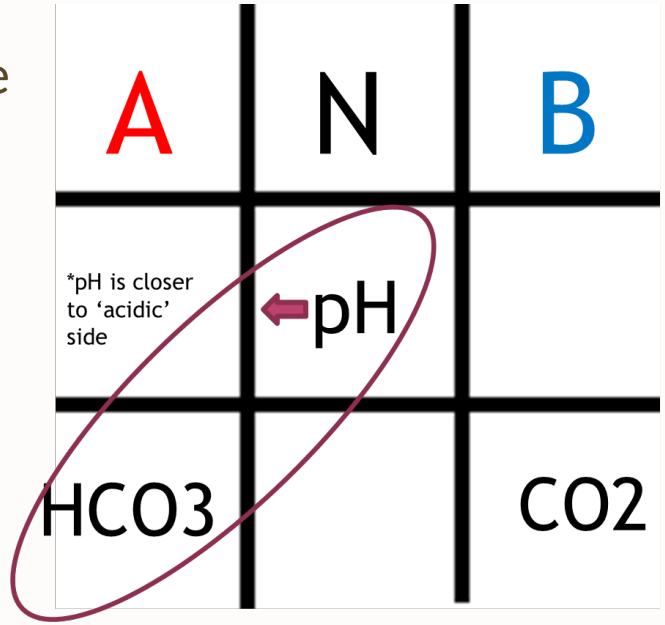


- Partially Compensated Metabolic Alkalosis with Severe Hypoxemia

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

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
- CO_2 55↑ A
- HCO_3 30↑ B

- CO_2 matches pH so Resp. Acisosis with partial compensation
- Arrows are moving in opposite direction pH ↓ & CO_2 ↑ (resp. opposite)

Mixed Acid Base Imbalance

- pH 6.8 A ↓
- CO_2 90 A ↑
- HCO_3 15 A ↓
  - RULE: when CO_2 or HCO_3 value is:
  - In a direction opposite to its predicted direction
  - Not close to the predicted value during normal compensatory activity