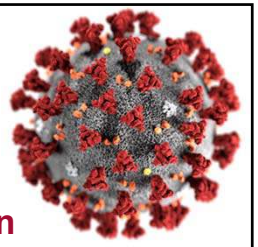
# COVID-19
# ABG Interpretation



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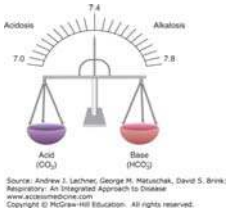
## Background

- Arterial blood gases are used to measure the amount of oxygen, carbon dioxide, and bicarbonate in the blood, as well as the pH.
- ABGs provide information regarding physiologic phenomena




Source: Andrew J. Lechner, George M. Matuschak, David S. Brink: Respiratory: An Integrated Approach to Disease
www.accessmedicine.com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## ABG Components

- pH
- PaCO2
- PaO2
- HCO3
- Oxygen Saturation (SaO2)
- Base Excess (Deficit)

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## Acids/Bases

Acids:

- Substances capable of releasing a hydrogen ion ($H^+$) into solution
- Volatile acids
  - excreted through the lungs ($CO_2$)
- Fixed or nonvolatile acids
  - excreted by the kidneys (ketoacids and lactic acid)

Bases:

- Substances capable of combining with $H^+$ in solution (buffer)
- Bicarbonate ($HCO_3$)
  - Most important base in the blood
  - regulated by the kidneys
- Hemoglobin and plasma proteins
- Bases are reflected in the ABGs as the $HCO_3$ and the base excess or base deficit


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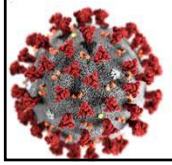
## Normal Values

pH: 7.35 – 7.45


- represents a combined effect of metabolic and respiratory factors.
- low pH indicates acidosis
- high pH indicates alkalosis



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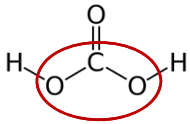
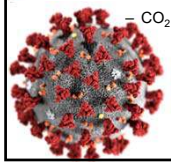
## Normal Values

$PaCO_2$: 35-45 mmHg




- A measure of the partial pressure of carbon dioxide dissolved in the plasma.
- Byproduct of metabolism
- $CO_2$ is excreted by the lungs and is a measure of the adequacy of ventilation.
- $CO_2$ functions as an acid because it combines with water to produce carbonic acid, $H_2CO_3$.



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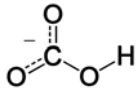
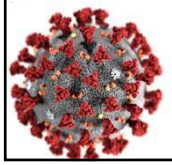
## Normal Values

$HCO_3$: 22-26 mEq/L




- Bicarbonate ion is a base regulated by the kidneys
- It may be adjusted to compensate for respiratory acid-base imbalance, or may be altered by other factors such as kidney disease or metabolic alterations



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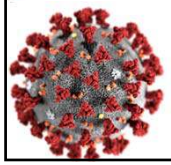
## Normal Values

Base Excess (Deficit): -2 - +2

- It represents the combined effects of $HCO_3$ and other bases--plasma proteins, hemoglobin and others
- A negative base excess is sometimes referred to as a base deficit.



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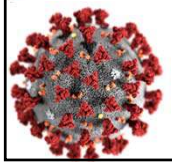
## Normal Values

### $PaO_2$: 80-100 mmHg

- Is the partial pressure of oxygen dissolved in arterial plasma
- Only about 1% of total oxygen content is carried in this state, $PaO_2$ indicates how well oxygen is being taken up in the lungs.



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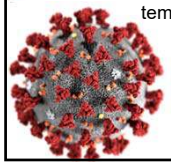
## Normal Values

### $SaO_2$: 95 to 98%

- $SaO_2$ represents the percentage of total hemoglobin which is saturated with oxygen.
- The vast majority of oxygen is carried in this state.
- While saturation is usually well-correlated with $PaO_2$, some conditions (pH, temperature) can influence the relationship between these two parameters



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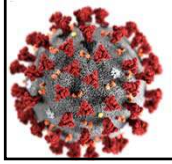
## ABG: Summary of Normal Values

| | |
|---|---|
| **pH** | **7.35 – 7.45** |
| **$PaO_2$** | **80 – 100 mmHg** |
| **$PCO_2$** | **35 – 45 mmHg** |
| **$HCO_3$** | **22 – 26 mEq/L** |
| **Base Excess (BE)** | **-2 - +2** |
| **$SaO_2$** | **95% - 98%** |



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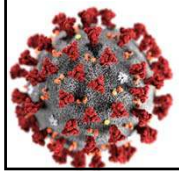
## ABG Interpretation Steps

1. Check pH (acidotic, alkalotic, or normal)
2. Check $PaCO_2$ (respiratory parameter)
   - ↑ (acidotic), ↓ (alkalotic), or normal
3. Check $HCO_3$ (metabolic parameter)
   - ↑ (alkalotic), ↓ (acidotic), or normal
4. Determine which of the major acid/base imbalances is present
5. Determine whether any compensation mechanisms are involved
6. Check PO2 and O2 saturation
   - normal, elevated, or decreased
7. Observe patient (evaluate vital signs and physical parameters)



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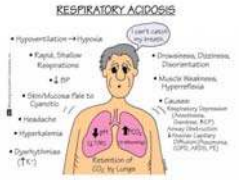
## Respiratory Acidosis (High PaCO2)

Hypoventilation

- Obstructive Lung Disease (COPD, sleep apnea)
- Oversedation, head trauma, anesthesia, or reduced function of respiratory center
- Neuromuscular disorders
- Chest Trauma (pneumothorax, flail chest)
- Inappropriate mechanical ventilation

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## Respiratory Alkalosis (low PaCO2)


Hyperventilation

- Hypoxemia
- Nervousness and anxiety
- Pulmonary Embolus
- Pulmonary Edema
- Response to respiratory stimulants (salicylates, theophylline, catecholamines)
- Inappropriate mechanical ventilation
- Compensation for metabolic acidosis

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## Metabolic Alkalosis (Elevated HCO3)

- Caused by a loss of nonvolatile acid or increase in HCO3
- Gastric loss of acid (vomiting, prolonged gastric suctioning)
- HCO3 during cardiac arrest
- Baking soda, antacids
- Massive blood transfusion – citrate – lactate - bicarbonate
- Increased excretion of H+, K+, and Cl – due to :
  - Diuretics
  - Cushing's Syndrome
  - Corticosteroids
  - Aldosteronism


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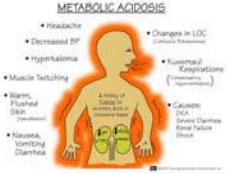
## Metabolic Acidosis (Low HCO3)

- Diabetic ketoacidosis
- Starvation
- Renal failure
- Lactic Acidosis
- Poisoning (salicylates, ethylene glycol, methyl alcohol, paraldehyde)
- Diarrhea
- Drainage of pancreatic fluids
- Treatment with diamox
- Treatment with ammonium chloride
- Renal Tubular Acidosis
- Hyperalimentation

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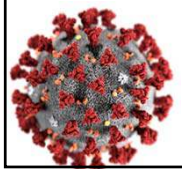
## Clinical Signs of Acidosis (CNS Depression)

- Depressed thought processes
- Delayed reaction times
- Slurred speech
- Somnolence
- Uncoordination
- Confusion
- Semi-coma
- Death



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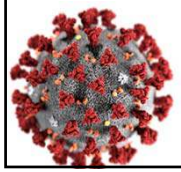
## Clinical Signs of Alkalosis (CNS-Excitation)

- Anxiety
- Paresthesia
- Tremors
- Nausea
- Tetany
- Convulsions
- Death



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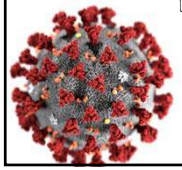
## Respiratory Acidosis

| | |
|---|---|
| pH | 7.30 |
| $PaCO_2$ | 65 |
| $PaO_2$ | 90 |
| $HCO_3$ | 26 |
| BE | 0 |
| $SaO_2$ | 95% |



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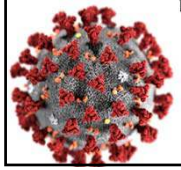
## Respiratory Alkalosis

| | |
|---|---|
| pH | 7.5 |
| $PaCO_2$ | 30 |
| $PaO_2$ | 90 |
| $HCO_3$ | 26 |
| BE | 0 |
| $SaO_2$ | 95% |



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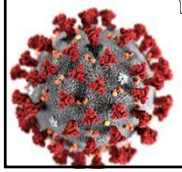
## Metabolic Acidosis

| | |
|---|---|
| pH | 7.3 |
| $PaCO_2$ | 35 |
| $PaO_2$ | 92 |
| $HCO_3$ | 18 |
| BE | -3 |
| $SaO_2$ | 97% |



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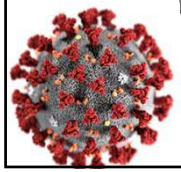
## Metabolic Alkalosis

| | |
|---|---|
| pH | 7.5 |
| $PaCO_2$ | 40 |
| $PaO_2$ | 95 |
| $HCO_3$ | 35 |
| BE | +3 |
| $SaO_2$ | 96% |



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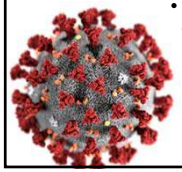
## Compensation

- Respiratory acidosis due to increased $PaCO_2$
  - Compensation: Kidneys excrete more acid and less $HCO_3$- resulting in increased $HCO_3$-
- Respiratory alkalosis due to decreased $PaCO_2$
  - Compensation: Kidneys excrete $HCO_3$-
- Metabolic acidosis due to decreased $HCO_3$-
  - Compensation: Hyperventilation to decrease $PaCO_2$
- Metabolic alkalosis due to increased $HCO_3$-
  - Compensation: Hypoventilation to increase $PaCO_2$



2 Types:
- Partial Compensation
- Full Compensation

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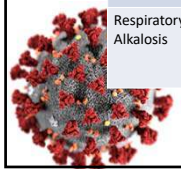
## ABG Summary

| Primary Disorder | Cause | Compensation | Effect on ABGs |
|---|---|---|---|
| Metabolic Acidosis | •Excess nonvolatile acids<br>•Bicarbonate deficiency | Rate & depth of respirations increase → eliminates additional CO2 | ↓ pH<br>↓ HCO3<br>↓ PaCO2 |
| Metabolic Alkalosis | •Bicarbonate excess | Rate & depth of respirations decrease → retaining CO2 | ↑ pH<br>↑ HCO3<br>↑ PaCO2 |
| Respiratory Acidosis | •Retained CO2 & excess carbonic acid | Kidneys conserve bicarbonate to restore carbonic acid : bicarbonate ratio 1:20 | ↓ pH<br>↑ PaCO2<br>↑ HCO3 |
| Respiratory Alkalosis | •Loss of CO2 & deficient carbonic acid | Kidneys excrete bicarbonate and conserve H+ to restore carbonic acid : bicarbonate ratio | ↑ pH<br>↓ PaCO2<br>↓ HCO3 |



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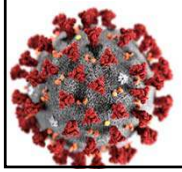
## Let's Practice

| | |
|---|---|
| **pH** | **7.42** |
| **$PCO_2$** | **50** |
| **$PO_2$** | **80** |
| **$HCO_3$-** | **32** |
| **BE** | **2.5** |
| **$SaO_2$** | **95%** |



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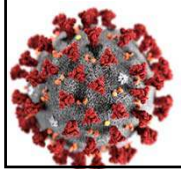
## Let's Practice

| | |
|---|---|
| **pH** | **7.37** |
| **$PCO_2$** | **32** |
| **$PO_2$** | **90** |
| **$HCO_3$** | **18** |
| **BE** | **-2.5** |
| **$SaO_2$** | **98%** |



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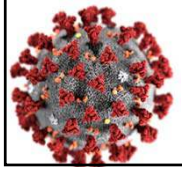
## Let's Practice

| | |
|---|---|
| **pH** | **7.39** |
| **$PCO_2$** | **64** |
| **$PO_2$** | **65** |
| **$HCO_3$** | **37** |
| **$Fi0_2$** | **.30** |
| **P/F Ratio** | **217** |



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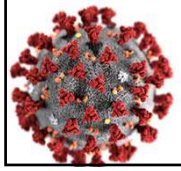
## Let's Practice

| | |
|---|---|
| **pH** | **7.45** |
| **$PCO_2$** | **27** |
| **$PO_2$** | **65.5** |
| **$HC0_3$** | **19.1** |
| **$Fi0_2$** | **.40** |
| **$SP0_2$** | **.88** |



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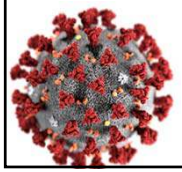
## Let's Practice

| | |
|---|---|
| **pH** | **7.12** |
| **$PCO_2$** | **67** |
| **$PO_2$** | **45** |
| **$HC0_3$** | **12** |
| **$Fi0_2$** | **.40** |
| **$SP0_2$** | **.78** |



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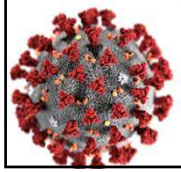
## Case Scenario

A patient with renal failure has the following ABG:

| | |
|---|---|
| **pH** | **7.38** |
| **$PaC0_2$** | **29** |
| **$HCO_3^-$** | **17** |



This Imbalance is MOST LIKELY:

1. Compensated metabolic acidosis
2. Compensated respiratory acidosis
3. Compensated respiratory alkalosis
4. Compensated metabolic alkalosis

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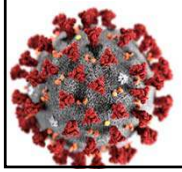
## Case Scenario

A patient has had an NG tube to intermittent suction for 4 days following abdominal surgery, her ABGs are:

| | |
|---|---|
| **pH** | **7.51** |
| **$PaC0_2$** | **45** |
| **$HCO_3^-$** | **31** |



This Imbalance is MOST LIKELY:

1. Compensated metabolic acidosis
2. Compensated respiratory acidosis
3. Uncompensated metabolic acidosis
4. Uncompensated metabolic alkalosis

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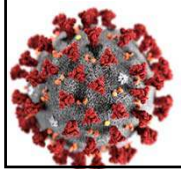
## Case Scenario

ABGs drawn from a patient in septic shock are:

| | |
|---|---|
| **pH** | **7.25** |
| **$PaC0_2$** | **36** |
| **$HCO_3^-$** | **14** |



This Imbalance is MOST LIKELY:

1. Uncompensated respiratory alkalosis
2. Uncompensated respiratory acidosis
3. Uncompensated metabolic acidosis
4. Uncompensated metabolic alkalosis

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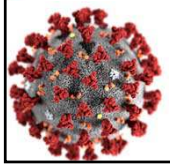
## $PaO_2/FiO_2$ (P/F) Ratio

Relationship of amount of additional oxygen to create a specific $PaO_2$

- $PaO_2/FiO_2$
- Normal > 300

| | Patient 1 on Room Air | Patient 2 on CMV (vent) |
|---|---|---|
| $PaO_2$ | 60 | 90 |
| $FiO_2$ | Room Air (21%) | 50% |
| P/F Ratio | | |



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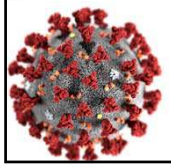
## P/F Ratio Practice

| PaO2 | FiO2 | P/F Ratio |
|---|---|---|
| 100 | .40 | 100/.4= |
| 100 | 1.0 | 100/1= |
| 200 | 1.0 | 200/1= |
| 200 | 0.8 | 200/.8= |



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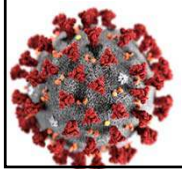
## Questions?

Email: klurban@uams.edu



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