BLOOD GAS BREAKDOWN

WES BROWNFIELD, RRT

A tool that objectively measures the function of the pulmonary system

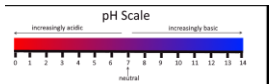
COMPONENTS OF A BLOOD GAS

- ph
- PaCO2
- PaO2
- SaO2
- HcO3-
- BE

pH

The measurement of the acidity or alkalinity of a blood sample.

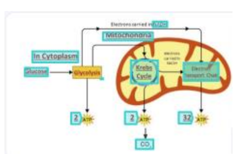
Normal Range: 7.35-7.45
Lower pH = acidic
Higher pH = alkaline



PaCO2

- PaCO2 : The Partial Pressure of CO2 in arterial blood
- The primary acid component. Approximately 98% of the acid load in blood is in the form of CO2
- Normal Range: 35-45 mmhg

CO2 is a byproduct of cellular metabolism, and is excreted through ventilation



PaO2

The Partial pressure of O2 dissolved in plasma

Age Specific Normal Values (r/a, @ sea level)

- 60 yo >80mmhg
- 70 yo >70mmhg
- 80 yo >60mmhg
- 90 yo >50mmhg

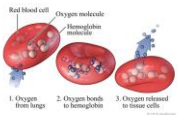
Atmospheric PO2 decreases as elevation increases.

FiO2 to PaO2 relationship for normal lungs. To assess oxygenation with supplemental O2 multiply FiO2 x 5

- 30% >150
- 40% >200
- 50% >250
- 80% >400
- 100% >500

SaO2

SaO2 is the percentage of available hemoglobin binding sites that are chemically bound with oxygen. This exchange happens at the alveoli.



- Normal range ≥95%
- Mild hypoxemia 90-94%
- Moderate hypoxemia 75-89%
- Severe hypoxemia < 75%

PO2/Sa02 relation in normal lungs

- PO2 27 = SaO2 50%
- PO2 60 = SaO2 90%
- PO2 80 = SaO2 95%
- PO2 97 = SaO2 97%

HCO3- (bicarb)

The alkaline component

Renal buffering mechanisms result in hydrogen ions being excreted into urine, and bicarbonate ions released into the blood

- Three major renal mechanisms are responsible
- Longer process vs CO2 excretion
- Normal range 22-26 mmol/L (millimoles/Liter)

BE (base excess/deficit)

- Measurement of overall buffering capacity
- This capacity diminishes with acidemia/alkalemia
- Normal range: -2 to +2

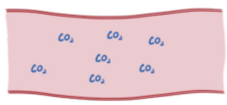
Respiratory Acidosis

Uncompensated (acute)

pH low, PaCO2 high, HCO3- Normal

Interventions:

- Increase ventilation to blow off CO2
- BiPap-initiate bipap or increase pressure support (widen the difference between ipap and epap)
- Ventilator- intubate or increase Minute Ventilation



Respiratory Acidosis

Compensated (chronic)

pH normal (but on lower side), PaCO2 High, HCO3- High

- **COPD**
- **Obesity Hypoventilation/OSA**

Acute-on-chronic

- **pH low, PaCO2 Extra High, HCO3- High**

Respiratory Acidosis

Uncompensated, compensated, or acute on chronic?

pH: 7.36 PCO2: 57 HCO3: 32

pH: 7.27 PCO2: 72 HCO3: 30

pH: 7.40 PCO2: 40 HCO3: 22

pH: 7.30 PCO2: 52 HCO3: 20

Respiratory Alkalosis

Acute- pH high, PaCO2 low, HCO3- Normal

Three broad circumstances result in respiratory alkalosis (aka hyperventilation):

- Hypoxemia
- Metabolic component
- Abnormal CNS stimulation

Compensated (chronic)- ph high end of normal, PaCO2 Low, HCO3 low

- Typically chronic neurologic issues or respiratory center injuries

Respiratory Alkalosis

Compensated or Uncompensated?

pH: 7.45 PaCO2: 30 HCO3: 19

pH: 7.52 PaCO2: 27 HCO3: 23

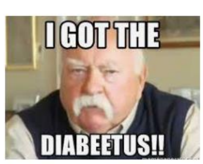
pH: 7.44 PaCO2: 31 HCO3: 22

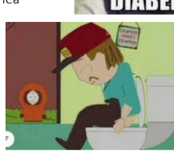
pH: 7.50 PaCO2: 29 HCO3: 24

Metabolic Acidosis

ph low, PaCO2 low end of normal, HCO3- low

- Diabetic Ketoacidosis
- Dehydration
- Loss of HCO3 from severe diarrhea





Metabolic Acidosis

Compensated:

pH normal but low, PaCO2 low, HCO3 low

- An underlying pathology has resulted in disturbances in acid/base production or excretion
- Chronic GI bicarbonate losses

Metabolic Alkalosis

Uncompensated (acute)
Acute- pH High, PaCO2 normal, HCO3- High

- Serum electrolyte imbalance, hypokalemia

Compensated (chronic)

pH high normal, PaCO2 High, HCO3 High

Probable cause: underlying pathology resulting in chronic disturbances in acid production / excretion, and renal / GI bicarbonate losses

Combined acidosis/alkalosis

= Mutli System Compromise

Patients with a combined acidosis/alkalosis are often very critically ill and require rapid intervention to reduce the probability of a cardiovascular compromise/collapse

Putting it all together

Practice interpretations

pH 7.40
PCO2 40
PO2 90
SaO2 99%
HCO3 24
BE 0

Normal blood gas

Putting it all together

Practice interpretations

pH 7.20
PaCO2 62
PaO2 60
SaO2 90%
HCO3 22
BE 1

Respiratory acidosis with mild hypoxemia

Mild hypoxemia = SaO2 90-94%

Putting it all together

Practice interpretations

pH 7.51
PaCO2 30
PaO2 58
SaO2 87%
HCO3 23
BE 2

Respiratory Alkalosis w/moderate hypoxemia

Moderate Hypoxemia= SaO2 75-89%

Putting it all together

Practice interpretations

pH 7.36
PaCO2 62
PaO2 80
SaO2 95%
HCO3 31
BE 3

Compensated Respiratory Acidosis

Putting it all together

Practice interpretations

pH 7.30
PaCO2 30
PaO2 99
SaO2 100%
HCO3 16
BE -10

Metabolic Acidosis

Putting it all together

Practice interpretations

pH 7.54
PaCO2 44
PaO2 87
SaO2 96%
HCO3 32
BE +12

Metabolic Alkalosis

Case Study #1

A 36 y/o woman was found unconscious at her home with an empty narcotic bottle nearby. She presents to the ER difficult to arouse with snoring respirations, and was placed on a non-rebreathing mask. Her RR is 6 breaths/min. An ABG was drawn:

pH 7.20 PaCO2 60 PaO2 60 SaO2 90%
HCO3- 24 BE -1

Interpretation

Uncompensated respiratory acidosis, due to acute narcotic intoxication. Due to her mental status in conjunction with acute acidosis, she was intubated and placed on a mechanical ventilator.

The next day she woke up suddenly and became violent, then self extubated. She walked out of the ICU and left AMA.

Case Study #2

A 78 y/o male with a known history of COPD and chronic hypercapnia presents to the ER alert and cooperative. He is in obvious respiratory distress with audible wheezing and is in the "tripod" position. He remains on his home oxygen flow of 2 liters/min, and his pulse ox reads 89%. An abg was drawn:

pH 7.25 PaCO2 90 PaO2 58 SaO2 88%

HCO3- 38, BE +12.

Interpretation:

Acute-on chronic respiratory acidosis due to acute exacerbation of COPD

Intervention: Patient was placed on Bipap with a low FiO2 and given a 1 hour abluterol/Atrovent neb along with a dose of solu-medrol. 2 hours have passed and he is now yelling "get this mask off my face". Repeat abg shows pH 7.35, PaCO2 60, PaO2 65, HCO3- 39.

This is likely the patient's baseline status, and attempts can be made to DC bipap therapy.

Case Study #3

A 53 y/o female with a history of CFH is brought to the emergency department by her husband who reports that she had a chest cold with a rattling cough two weeks ago, but is increasingly short of breath. She is currently on room air, and an abg and chest xray are ordered. The abg reveals:

pH 7.54 PCO2 26 PaO2 48 SaO2 85%

HCO3- 22 BE 0

Her chest xray reveals a significant right pleural effusion.

Interpretation: respiratory alkalosis with moderate hypoxemia

Intervention: Patient was administered oxygen at 6 L/min and a throracentisis removed 3L of fluid.

Repeat abg's with 6 L/nc pH 7.42, PaCO2 36, PaO2 90, HCO3- 22, SaO2 97%.

Interepretation: normal ventilatory status with corrected hypoxemia. Her initial alkalosis was caused by hypoxemia due to a pleural effusion, which drove her shortness of breath.

Case Study # 4

A 47 y/o firefighter was overcome by smoke and required rescue from a burning building. He was brought to the ER with his only compliant being short of breath. Staff placed a nonrebreathing mask at max flow. His pulse ox on the monitor shows a 98% saturation. An abg was drawn and reveals

pH 7.59 PaCO2 24 PaO2 376 SaO2 62%, HCO3- 22 BE 2

Interpretation: Respiratory alkalosis due to hypoxemia

Why did the monitor show 98% vs the abg SaO2 of 62%?

CO has 200-250x the affinity for hemoglobin compared with oxygen, decreases the availability of hemoglobin for oxygen transport. A standard SpO2 monitor cannot differentiate between hemoglobin saturated with CO and 02. A blood gas determines actual O2 hemoglobin saturation.

Intervention: 100% O2 via mask for several hours until abgs show oxygen saturation levels return to normal.

Case Study #5

A 19 y/o woman with insulin dependent diabetes enters the ER with Kussmaul Breathing (rapid and deep as possible). Room air abgs reveal

pH 7.05 PaCO2 14 PaO2 109

HCO3- 5 BE -27

Her glucose level is 350 mg/dL

Interpretation: acute metabolic acidosis due to diabetic ketoacidosis.

Intervention: IV insulin. Sodium bicarb can be helpful to restore acid base balance.

QUESTIONS?