ABG INTERPRETATION
&
ACID – BASE DISORDERS

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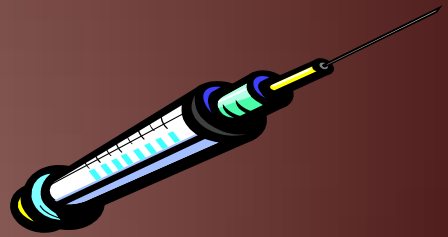


What is an ABG

Arterial Blood Gas

Drawn from artery- radial, femoral, axillary (avoided from brachial).

It is an **invasive** procedure.

Helps in assessing respiratory status .

Helps in assessing acid-base disorders. (complete analysis needs Electrolyte Values)

What Is An ABG?

pH $[H^+]$

pCO_2 Partial pressure CO_2

pO_2 Partial pressure O_2

HCO_3 Bicarbonate (calculated)

BE Base excess (the amount of H+ ions that would be required to return the pH of the blood to normal if the pCO2 were adjusted to normal.)

a base excess > +3 = metabolic alkalosis

a base excess < -3 = metabolic acidosis

SaO_2 Oxygen Saturation

Acid/Base Relationship

- **This relationship is critical for homeostasis**
- **Significant deviations from normal pH ranges are poorly tolerated and may be life threatening**
- **Achieved by Respiratory and Renal systems & Maintained in conjunction with the buffer systems.**

Respiratory Component

- Function of the lungs
- Carbonic acid H_2CO_3
- Approximately 98% normal metabolites are in the form of CO_2

$$CO_2 + H_2O \leftrightarrows H_2CO_3$$

- excess CO_2 exhaled by the lungs

Metabolic Component

- Function of the kidneys

- base bicarbonate Na HCO_3

- Process of kidneys excreting H^+ into the urine and reabsorbing HCO_3^- into the blood from the renal tubules
    1) active exchange Na^+ for H^+ between the tubular cells and glomerular filtrate

Normal ABG values

pH	7.35 – 7.45	(7.40)
PCO_2	35 – 45 mmHg	(40)
PO_2	80 – 100 mmHg	
HCO_3	22 – 26 mmol/L	(24)
BE	-2 - +2	
SaO_2	>95%	

To convert kPa to mmHg multiply by 7.5

Respiratory Acidosis

- Think of CO_2 as an acid

- Failure of the lungs to exhale adequate CO_2

  $pH < 7.35$

  $pCO_2 > 45$

Causes of Respiratory Acidosis

- COPD
- severe asthma
- drug overdose
- respiratory arrest
- airway obstruction

Metabolic Acidosis

- failure of kidney function or loss of Bicarbonate

- failure to excrete acid by kidneys

- excess production of acid – sepsis (lactic acidosis, methanol poisoning)

- ↓ blood HCO_3 which results in ↓ availability of renal tubular HCO_3 for H^+ excretion

  pH < 7.35

  HCO_3 < 22

Anion Gap

$$(Na^+ + K^+) – (HCO3^- + Cl^-)$$

Normal range 10 – 14 (varies from lab to lab)

- ↑ anion gap
  - DKA
  - Renal failure
  - Lactic acidosis
  - poisoning eg. salicylate, ethylene glycol, methanol
- Normal anion gap
  - Chronic diarrhoea, ileostomy
  - Addison's disease
  - Pancreatic fistula
  - Renal tubular acidosis

These lists are not exhaustive

Respiratory Alkalosis

- too much CO_2 exhaled (hyperventilation)
- ↓ PCO_2 insufficiency = ↑ pH
- pH > 7.45
- pCO_2 < 35

Causes of Respiratory Alkalosis

- hyperventilation
- panic d/o
- pain
- pregnancy
- acute anemia
- salicylate overdose

Metabolic Alkalosis

- ↑ plasma bicarbonate
  - pH > 7.45
  - HCO_3 > 26

Causes of Metabolic Alkalosis

- ↑ loss acid from stomach or kidney
- hypokalemia
- excessive alkali intake
- contraction alkalosis (diuretics, hypovoleumia)

Basic Changes in Various Disorder

	pH	CO_2	HCO_3
Met Acidosis	↓	↓	↓
Resp Acidosis	↓	↑	↑
Met Alkalosis	↑	↑	↑
Resp Alkalosis	↑	↓	↓

Acid Base Disorders can be Simple or Mixed

Respiratory Acidosis & Respiratory Alkalosis
NEVER COEXISTS

All Other Combinations Are Possible

How to Analyze an ABG

Two Components:

Oxygenation & Ventilation

Acid Base Analysis – which requires concomitant Serum Electrolyte values

How to Analyze an ABG

1. PO_2 NL = 80 – 100 mmHg

2. pH
   NL = 7.35 – 7.45 (7.4)
   Acidotic <7.35
   Alkalotic >7.45

3. PCO_2
   NL = 35 – 45 mmHg (40)
   Acidotic >45
   Alkalotic <35

4. HCO_3
   NL = 22 – 26 mmol/L (24)
   Acidotic < 22
   Alkalotic > 26

Steps to analysing an ABG

1. Is the patient hypoxic?

2. Is there a significant degree of lung injury?

A – a Gradient

The gradient between alveolar PAO2 and arterial PaO2 in a person with healthy lungs is ~ 10 kPa

The higher the gradient, the worst the lung injury

ABG Interpretation

Step 1:

- Examine PaO_2
- Determine oxygen status
- Low PaO_2 (<80 mmHg) means hypoxemia
- NL/ elevated oxygen means adequate oxygenation

ABG Interpretation

Step 2:

➢ pH	acidosis	<7.35
	alkalosis	>7.45

ABG Interpretation

Step 3:

- Determine the primary disorder
- Compensations never overshoot
- Limits of compensations

ABG Interpretation

Step 4: (compensation calculation)

Determine if there is a compensatory mechanism working to try to correct the pH.

ie: If there is a primary respiratory acidosis you will have an increased $PaCO_2$ and decreased pH. Compensation occurs when the kidneys retain HCO_3.

ABG Interpretation

Step 4: (compensation calculation)

For metabolic acidosis: (Winter's Formula)

Expected $PCO_2 = 1.5\ (HCO_3) + 8 \pm 2$

If actual value is more then coexisting resp acidosis

If actual value is less then coexisting resp alkalosis

For Metabolic Alkalosis:

For each 10 mmol change in HCO3; pCO2 change is 6 mmHg

ABG Interpretation

Step 4: (compensation calculation)

For respiratory acidosis:

Acute: for each 10 mmHg pCO_2 – HCO_3 change by 1 or pH change by 0.08

Chronic: for each 10 mmHg pCO_2 – HCO_3 change by 4 or pH change by 0.03 (max HCO_3 35-40)

For respiratory alkalosis:

Acute: for each 10 mmHg pCO_2 – HCO_3 change by 2 or pH change by 0.08 (min HCO_3 18)

Chronic: for each 10 mmHg pCO_2 – HCO_3 change by 4 or pH change by 0.03 (min HCO_3 15)

ABG Interpretation

Step 5:

Anion Gap -

Na – (Cl + HCO3) normal ~12

Step 6 :

Delta Gap -

Pt's gap – normal anion gap

Corrected HCO3 = Pt's HCO3 + delta gap

if >24 then coexisting met alkalosis

if <24 then coexisting NAGMA

Respiratory Acidosis

pH 7.30

$PaCO_2$ 60

HCO_3 26

Respiratory Alkalosis

pH 7.50

$PaCO_2$ 30

HCO_3 22

Metabolic Acidosis

pH 7.30

$PaCO_2$ 40

HCO_3 15

Metabolic Alkalosis

pH 7.50

PCO_2 40

HCO_3 30

Case study - 1

27 yo male with Type1 DM arrived at ER on room air ABG :

pH	7.25	Na	140
pCO_2	22 mmHg	K	5.5
HCO_3	9 mmol /L	Cl	104
		TCO2	8

Interpretation:
Acidosis
Metabolic
Expected pCO2 = (8X1.5) + 8 = 18 - 22
AG = 140 – (104+8) = 28
Delta Gap = 28 – 12 = 16,
corrected HCO3 = 16 + 8 = 24
Compensated AG Metabolic Acidosis

Case study 2

17 yo female had a RTA & was unhurt but developed carpo-pedal spasm, police brought her to ER

pH	7.52	Na	140
PCO_2	24 mmHg	K	4.0
HCO_3	21 mmol/L	Cl	109
		TCO2	21

Interpretation:

Alakalosis

Respiratory

For ~ 15 decrease in PCO2; expected pH 7.52, HCO_3 21

Acute Respiratory Alkalois.

Case study - 3

55 yo male presented with abdominal pain, nausea, vomiting & shock.
Was diagnosed as pancreatitis:

pH	7.25	Na	140
PCO_2	20 mmHg	K	5.5
HCO_3	12 mmol/L	Cl	99
		TCO2	12

Interpretation:
Acidosis
Metabolic
Expected PCO2 = (12 X1.5) + 8 = 24 - 28
AG = 140 – (99+12) = 29
Delta Gap = 29 – 12 = 17,
corrected HCO3 = 17 + 12 = 29
AGMA with Resp Alkalosis with met alkalosis

Take Home Message:

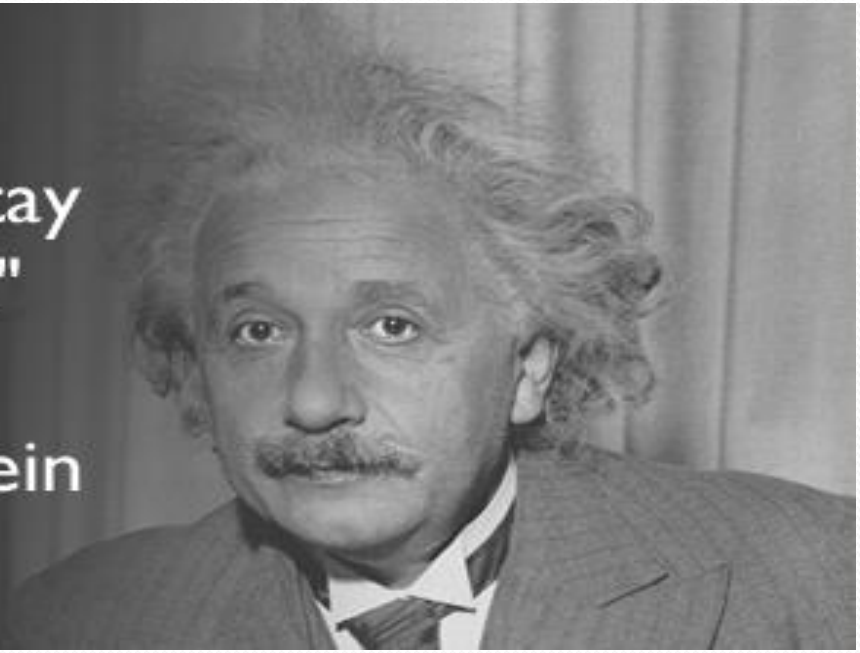
- Valuable information can be gained from an ABG as to the patients physiologic condition

- Remember that ABG analysis is only part of the patient assessment.

- Be systematic with your analysis, start with ABC's as always and look for hypoxia (which you can usually treat quickly), then follow the steps completely – do not assume.

"It's not that I'm so smart, it's just that I stay with problems longer."

–Albert Einstein



Thank You