Arterial Blood Gas Analysis & Interpretation

ABG = Arterial Blood Gas

It is estimation of different blood gas component in arterial blood. E.g.

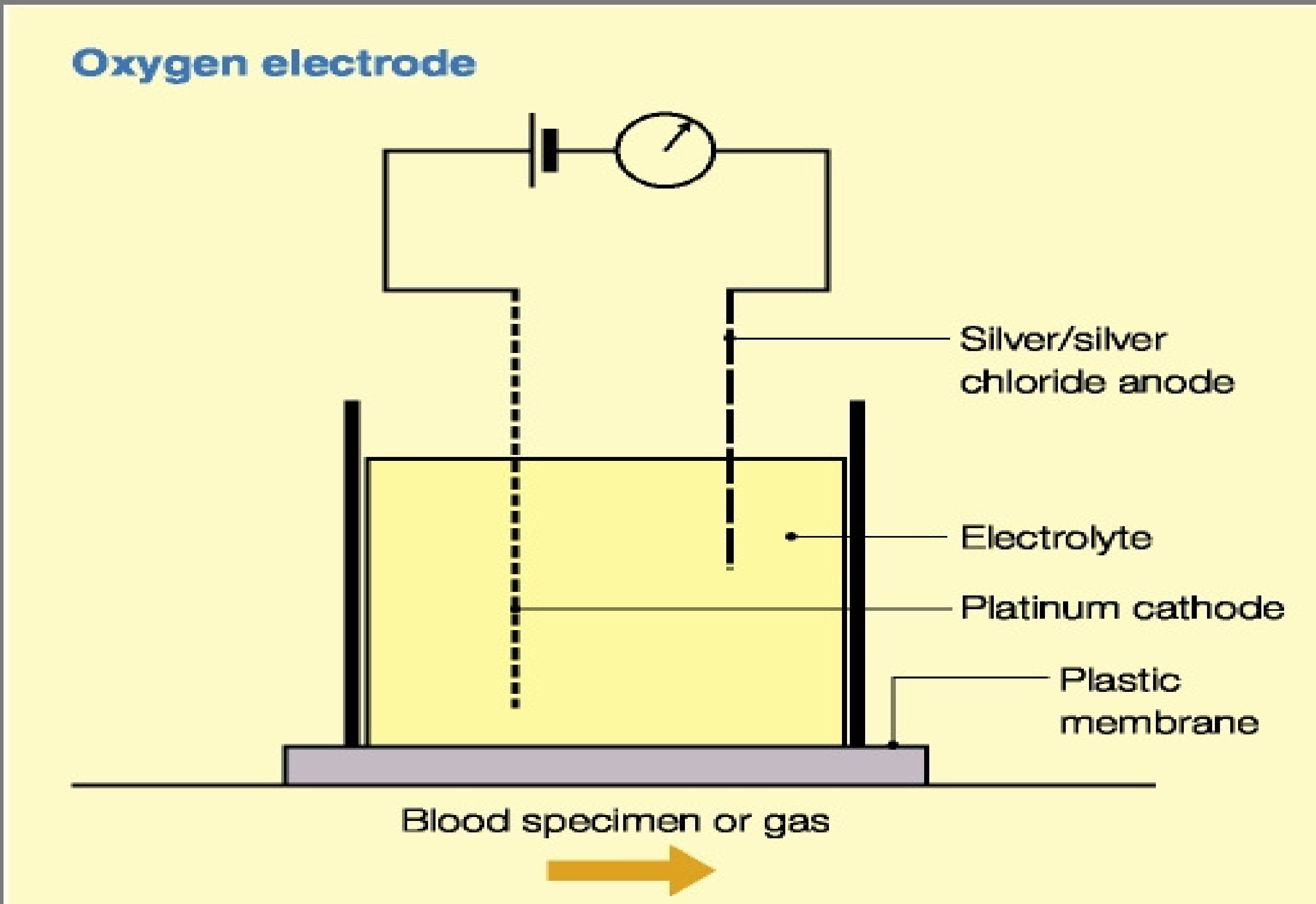
- partial pressure of oxygen (pO2)
- pCO2
- pH
- Conc. Of HCO3
- Base Excess (BE)
- SpO2

Which is an essential to manage the patient's oxygenation status as well as patient on ventilation and diagnose acid base balance.

Principle

- By the specific electrode particular gas component is diffused through the membrane & it will make change in electrical potential.
- That change in electrical potential reflect concentration of gas in Blood.

Principle


Oxygen electrode
Silver/silver chloride anode
Electrolyte
Platinum cathode
Plastic membrane
Blood specimen or gas

Normal Arterial Blood Gas Values

pH	7.35 - 7.45
$PaCO_2$	32 - 36 mm Hg
PaO_2	90 - 100 mm Hg
SaO_2	95 - 100%
HCO_3^-	22 - 26 mEq/L
Base excess	-2.0 to 2.0 mEq/L

pH

- Not a gas
- But a measurement of acidity or alkalinity, based on the hydrogen (H+) ions concentration in blood.
- The pH of a solution is equal to the negative log of the hydrogen ion concentration in that solution:

$$pH = -\log [H^+]$$

pO2

- The partial pressure of oxygen that is dissolved in arterial blood.
  New Born – Acceptable range 40-70 mmHg.
- PO2 determination is carried out to assess the O2 carrying capacity of blood Hb.
- A low pO2 is measure of Hypoxia .
- A low pO2 with high pCO2 may also be observed in pulmonary edema.

HCO3

- The calculated value of the amount of bicarbonate in the bloodstream.
- Not a blood gas but the anion of carbonic acid.

- Hco3 = [pCO2]antilog[pH-pK’a]

SpO2

- The arterial oxygen saturation with haemoglobin.

pCO2

- The amount of carbon dioxide dissolved in arterial blood.
- Partial pressure of arterial CO2.
- CO2 is called a “volatile acid” because it can combine reversibly with H2O to yield a strongly acidic H+ ion and a weak basic bicarbonate ion (HCO3 -) according to the following equation:

- $CO_2 + H_2O \leftarrow H_2CO_3 \rightarrow H^+ + HCO_3$

Base Excess

- Normal range is between -2.0 to +2.0
- Indicates the level of bicarbonate.
- Negative B.E. = Base deficit = Acidosis.
- Positive B.E. = Base Excess = Alkalosis.
- Calculated value.
- The base excess is defined as the amount of $H+$ ions that would be required to return the pH of the blood to 7.35 if the $pCO2$ were adjusted to normal.

Calculation

Base excess = 0.93 (HCO3 - 24.4 + 14.8(pH - 7.4))

Base excess = 0.93×HCO3 + 13.77×pH - 124.58

PROCEDURE

1. Sterilized skin with alcohol.
2. Anesthetize site with 4 % Lidocaine.
3. *Take heparinized glass syringe.*
4. *Expel any residual heparin out through the needle. (The needle must be coated with heparin to prevent the formation of micro-clots).*
5. *Feel along the course of the radial artery and palpate for maximum pulsation with the middle and index finger. Prepare the skin with an alcohol.*
6. *Hold the needle at a 45-60 degree angle to the skin surface and advance in to the artery.*
7. *Once the artery is punctured, arterial pressure will push up the hub of the syringe and a pulsating flow of blood will fill the syringe.*
8. *Once blood is obtained, withdraw the needle firmly and apply pressure over the site with a dry sponge.*
9. *Than band needle to prevent gas exchange from air. Or Block needle with rubber.*
10. *Transport syringe with bag of ice.*
11. *Continue to maintain pressure of puncture site for up to 10 minutes. (If patient is on anticoagulant medication apply pressure for 15 minutes).*

Acid/Base Balance

- The pH is a measurement of the acidity or alkalinity of the blood.
- It is inversely proportional to the no. of (H+) in the blood.
- The normal pH range is 7.35-7.45.
- Significant changes in the blood pH above 7.8 or below 6.8 will interfere with cellular functioning, and if uncorrected, will lead to death.
- Changes in body system functions that occur in <u>an acidic state</u> decreases the force of cardiac contractions, decreases the vascular response to catecholamines, and a diminished response to the effects and actions of certain medications.
- An <u>alkalotic state</u> interferes with tissue oxygenation and normal neurological and muscular functioning.

Acid-base Terminology

- **Acidemia**: blood pH < 7.35
- **Acidosis:**
- Examples:
  - Metabolic acidosis, Diabetic ketoacidosis, lactic acidosis.
  - Respiratory acidosis from hypoventilation.
  - If the patient also has an alkalosis at the same time, the resulting blood pH may be low, normal, or high.

- **Alkalemia**: blood pH > 7.45
- **Alkalosis:**
  - Metabolic alkalosis from excessive diuretic therapy;
  - Respiratory alkalosis from acute hyperventilation.
  - If the patient also has an acidosis at the same time, the resulting blood pH may be high, normal, or low.

Acid-base Terminology

- **Primary acid-base disorder:**
  - *Metabolic acidosis*
  - *Metabolic alkalosis*
  - *Respiratory_acidosis*
  - *Respiratory alkalosis*
- **HCO3-**
  - reduced HCO3- and acidemia
  - elevated HCO3- and alkalemia.
- **PaCO2**
  - reduced PaCO2 and alkalemia.
  - elevated PaCO2 and acidemia.

Respiratory alkalosis

- With a pH more than 7.45
- pCO_2 less than 32 mmHg
- Cause
  - ✓ Hysteria, anxiety or fear.
  - ✓ Pain
  - ✓ Increased metabolic demands such as fever, sepsis, pregnancy or thyrotoxicosis.
  - ✓ Medications such as respiratory stimulants.
  - ✓ Central nervous system lesions

Metabolic alkalosis

- With a pH more than 7.45
- Bicarbonate more than 26 mEq /L
- Cause
  - ✓Excess of base
    - Ingestion of excess antacids,
    - excess use of bicarbonate
  - ✓loss of acid
    - Excessive vomiting,
    - Gastric suction,
    - excess use of diuretics

Respiratory Acidosis

- With a pH less than 7.35
- pCO_2 > 36 mmHg
- Cause = due to CO_2 retention
  - ✓Asthma
  - ✓Chronic Obstructive Pulmonary Disease

Metabolic Acidosis

- pH less than 7.35.
- Bicarbonate less than 22mEq/L

Cause = retention of H+ ion
= Loss of bicarbonate ion

- ✓Renal failure
- ✓Diabetic ketoacidosis
- ✓Anaerobic metabolism
- ✓Starvation
- ✓Salicylate intoxication

Uncompansated acid base balance

	pH	PaCo2	HC03
Respiratory acidosis	↓	↑	normal
Respiratory Alkalosis	↑	↓	normal
Metabolic Acidosis	↓	normal	↓
Metabolic Alkalosis	↑	normal	↑

Partially compensated

	pH	$paco_2$	Hco_3
Res.Acidosis	↓	↑	↑
Res.Alkalosis	↑	↓	↓
Met. Acidosis	↓	↓	↓
Met.Alkalosis	↑	↑	↑

FULLY COMPENSATED

	pH	paco2	Hco3
Resp.Acidosis	Normal but<7.40	↑	↑
Resp.Alkalosis	Normal but>7.40	↓	↓
Met. Acidosis	Normal but<7.40	↓	↓
Met. Alkalosis	Normal but>7.40	↑	↑

Stepwise approach to ABG

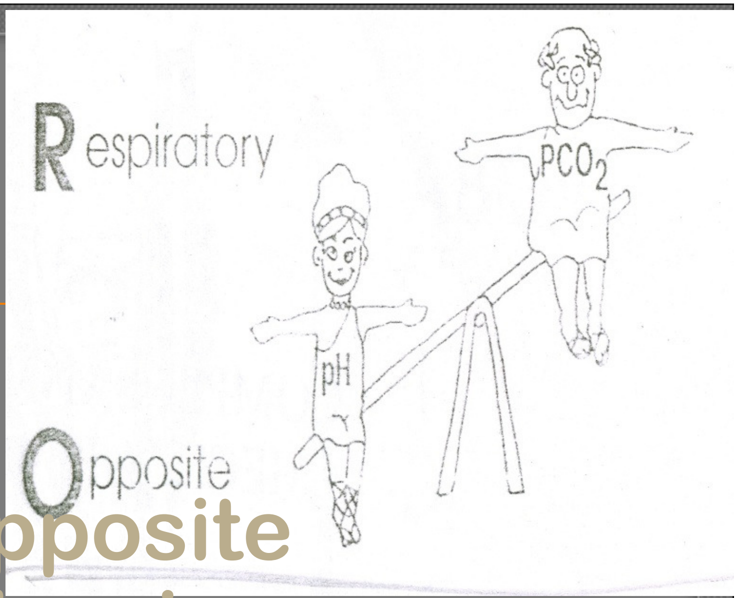
- Step 1: Acidemic or Alkalemic?
- Step 2: Is the primary disturbance respiratory or metabolic?
- Step 3. Asses to Pa O_2. A value below 80mm Hg indicates Hypoxemia. For a respiratory disturbance, determine whether it is acute or chronic.
- Step 4. For a metabolic acidosis, determine whether an anion gap is present.
- Step 5. Assess the normal compensation by the respiratory system for a metabolic disturbance

Step to ABG interpretation

Step:1

Assess the pH –acidotic/alkalotic

- If above 7.5 – alkalotic
- If below 7.35 – acidotic

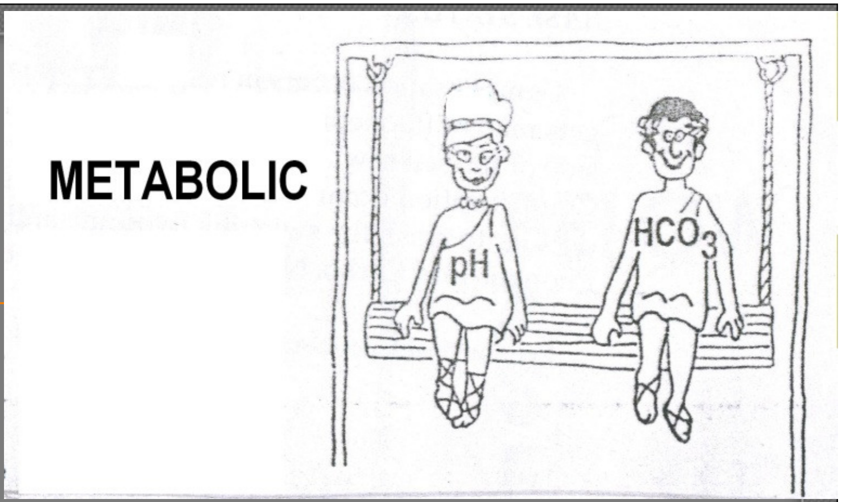


Step 2
Assess the $paCO_2$ level.

- pH and pCO_2 moves in opposite direction – Primary problem in respiratory system.
- Respiratory Acidosis
  - pH decreases below 7.35 & the $paCO_2$ should rise.
- Respiratory Alkalosis
  - pH rises above 7.45 & $paCO_2$ should fall.

Step:2

Assess HCO_3 value



- pH & HCO_3 are moving in the same direction, primary problem is metabolic
- Metabolic Alkalosis
  - pH increases & HCO_3 also increase
- Metabolic Acidosis
  - pH decreases & HCO_3 also decrease

Step 3
Assess pO2 < 80 mm Hg - Hypoxemia

For a respiratory disturbance : Acute or Chronic

- If the change in pCO_2 is associated with the change in pH, the disorder is acute.
- In chronic process the compensatory process brings the pH to within the clinically acceptable range (7.30 – 7.50)

Step 4 Evaluate Anion Gap

- Calculation of AG is useful approach to analyse metabolic acidosis

$$AG = (Na^+ + K^+) - (Cl^- + HCO_3^-)$$

- Hence there is a difference between cations and the anions.
- The unmeasured anions constitute the anion gap which is due to the presence of protein anions, sulfate, phosphate and organic acids.
- Normally this is about 10 - 12 mmol/liter.
- A change in the pH of 0.08 for each 10 mmol/L indicates an ACUTE condition.
- A change in the pH of 0.03 for each 10 mmol/L indicates a CHRONIC condition.

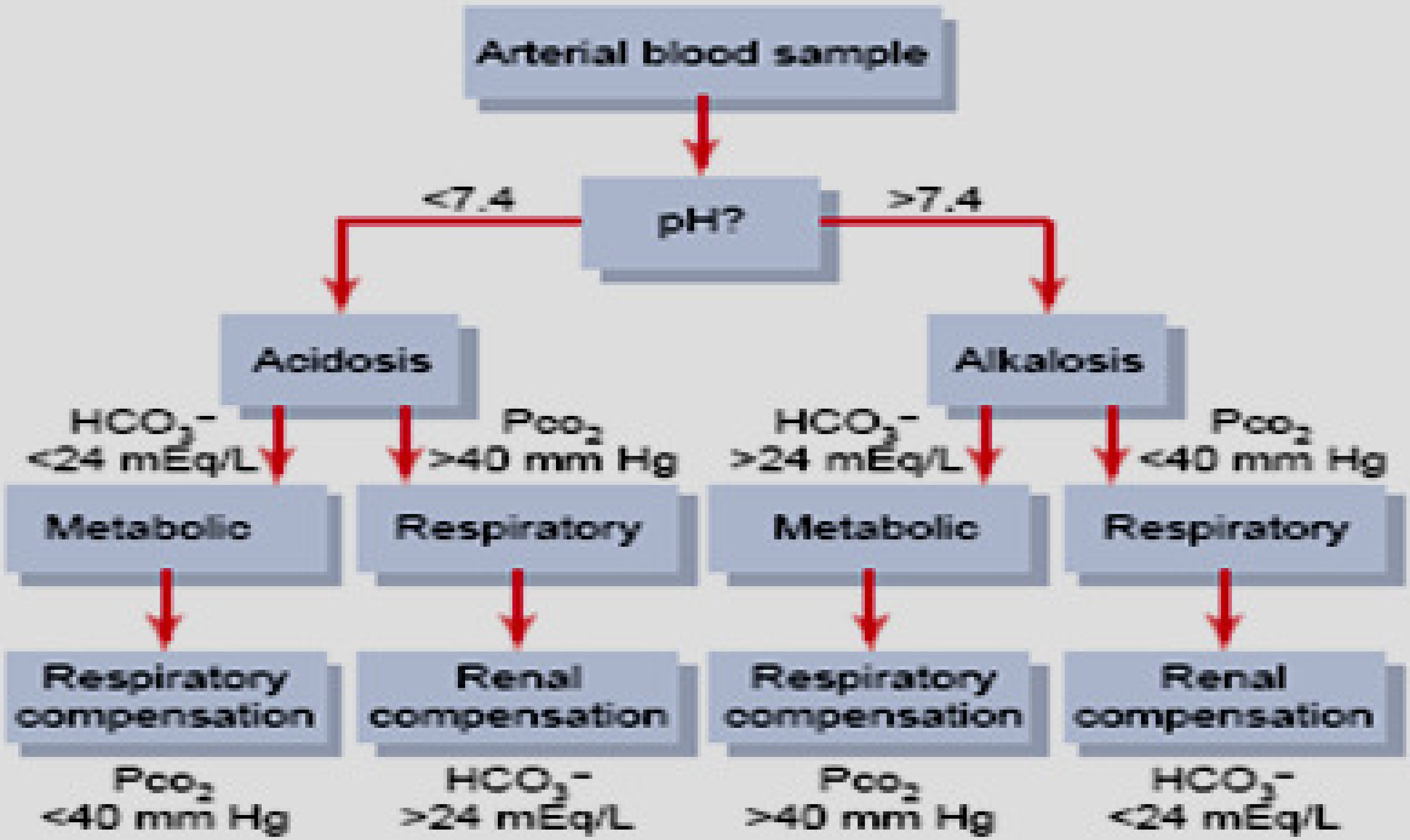


Figure 30–10

Analysis of simple acid-base disorders. If the compensatory responses are markedly different from those shown at the bottom of the figure, one should suspect a mixed acid-base disorder.


THANK YOU