

# Evaluating an arterial blood gas

1) First look at the pH. Is it high, low or normal?

Normal pH ranges from 7.35 to 7.45.  
The average pH is 7.40. If the value is above 7.40 there is alkalosis, if it is below 7.40 there is acidosis. The pH leans towards the initial disorder.

2) The next step is to look at the partial pressure of arterial carbon dioxide (PaCO2). Is it high, low or normal?

Normal PaCO2 ranges from 35 to 45 mm Hg.  
The average PaCO2 is 40 mm Hg. If the value is above 40 there is hypoventilation or compensation for a metabolic alkalosis. If the value is below 40 there is hyperventilation or compensation for a metabolic acidosis. The pH and PaCO2 should move in opposite directions.

3) The next step is to look at the bicarbonate (HCO3) level. Is it high, low or normal?

Normal HCO3 ranges from 22 to 26 mEq/L.  
The average HCO3 is 24 mEq/L. If the value is above 24 there is loss of acid or compensation for respiratory acidosis. If the value is below 24 there is loss of bicarbonate or compensation for respiratory alkalosis. The bicarbonate and pH should move in the same direction.

4) If both the PaCO2 and HCO3 are abnormal, which value corresponds more closely to the pH value? For example, if the pH indicates acidosis, which value also reflects acidosis an increased PaCO2 or a decreased HCO3? The value that more closely corresponds to the pH and deviates more from normal points to the primary disturbance. The body never over-compensates. A normal non-leaning pH with two abnormal indicators (PaCO2 and HCO3) suggests a mixed disorder.

5) The next step is to look at the partial pressure of arterial oxygen (PaO2) and oxygen saturation. Are they high, low or normal?

Normal PaO2 ranges from 80 to 100 mm Hg.  
Levels below 60 indicate hypoxemia.

# Anion gap

Normally the number of positively charged ions (cations) and the number of negatively charged ions (anions) are equal. The term anion gap refers to the difference between measured cations and measured anions. The normal anion gap is less than less than 16 mEq/L. Not all of the bodies cations and anions are measured. Sodium is considered the principle cation and chloride and bicarbonate are the principal anions.

$$\text{Anion gap} = \text{serum sodium} - \text{serum chloride} + \text{bicarbonate}$$

## Metabolic acidosis

Acidosis can coexist with a normal anion gap. Metabolic acidosis that occurs when a decrease in bicarbonate concentration is balanced by an increase in chloride concentration results in a normal anion gap. This type of acidosis is called hyperchloremic metabolic acidosis. Conditions that develop this type of acidosis are known by the acronym USED CARP.

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|--------------------------|------------------------------|
| Ureterosigmoidostomy     | Carbonic anhydrase inhibitor |
| Small bowel fistula      | Adrenal insufficiency        |
| Extra chloride ingestion | Renal tubular acidosis       |
| Diarrhea                 | Pancreatic fistula           |

## Anion gap metabolic acidosis

Anion gap metabolic acidosis occurs when a decrease in bicarbonate concentration is balanced by increased acid anions other than chloride. This causes the calculated anion gap to exceed the normal range. This type of acidosis is called normochloremic metabolic acidosis. Conditions that develop this type of acidosis are known by the acronym MUD PILES.

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|-----------------------|-----------------------------------|
| Methanol ingestion    | Paraldehyde ingestion             |
| Uremia                | Iatrogenic                        |
| Diabetic ketoacidosis | Lactic acidosis                   |
|                       | Ethylene glycol/ethanol ingestion |
|                       | Salicylate ingestion              |