Normal Arterial Blood Gas Values

<table>
<thead>
<tr>
<th>Value</th>
<th>Normal Range</th>
<th>Significance</th>
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</table>
| pH    | 7.35 to 7.45 | Reflects hydrogen ion (H\(^+\)) concentration  
\(\cdot \) < 7.35 = acidosis  
\(\cdot \) > 7.45 = alkalosis |
| PaCO\(_2\) | 35 to 45 mmHg | Partial pressure of carbon dioxide (CO\(_2\)) in arterial blood  
\(\cdot \) < 35 mmHg = hypocapnia  
\(\cdot \) > 45 mmHg = hypercapnia |
| Pao\(_2\) | 80 to 100 mmHg | Partial pressure of oxygen (O\(_2\)) in arterial blood  
\(\cdot \) < 80 mmHg = hypoxemia |
| HCO\(_3\)^- | 22 to 26 mEq/L | Bicarbonate concentration in plasma |
| BE | -3 to +3 | Base excess; a measure of buffering capacity |

PRACTICE ALERT You will see the abbreviations PaCO\(_2\) and Pao\(_2\) used interchangeably with P\(_2\)CO and P\(_2\)O. The P stands for partial pressure; the pressure exerted by the gas dissolved in the blood. The a indicates that the sample is arterial blood. Because these measurements rarely are done on venous blood, the a often is deleted from the abbreviation.

The PaCO\(_2\) measures the pressure exerted by dissolved carbon dioxide in the blood. The PaCO\(_2\) reflects the respiratory component of acid-base regulation and balance. The PaCO\(_2\) is regulated by the lungs. The normal value is 35 to 45 mmHg. A PaCO\(_2\) of less than 35 mmHg is known as hypocapnia; a PaCO\(_2\) greater than 45 mmHg is hypercapnia.

The Pao\(_2\) is a measure of the pressure exerted by oxygen that is dissolved in the plasma. Only about 3% of oxygen in the blood is transported in solution; most is combined with hemoglobin. However, it is the dissolved oxygen that is available to the cells for metabolism. As dissolved oxygen diffuses out of plasma into the tissues, more is released from hemoglobin. The normal value for Pao\(_2\) is 80 to 100 mmHg. A Pao\(_2\) less than 80 mmHg is indicative of hypoxemia. The Pao\(_2\) is valuable for evaluating respiratory function, but is not used as a primary measurement in determining acid-base status.

The serum bicarbonate (HCO\(_3\)^-) reflects the renal regulation of acid-base balance. It is often called the metabolic component of arterial blood gases. The normal HCO\(_3\)^- value is 22 to 26 mEq/L.

The base excess (BE) is a calculated value also known as buffer base capacity. The measurement of base excess reflects the degree of acid-base imbalance by indicating the status of the body’s total buffering capacity. It represents the amount of acid or base that must be added to a blood sample to achieve a pH of 7.4. This is essentially a measure of increased or decreased bicarbonate. The normal value for base excess for arterial blood is \(-3.0\) to \(+3.0\). Normal ABG values are summarized in Table 5–10.

ABGs are analyzed to identify acid-base disorders and their probable cause, to determine the extent of the imbalance, and to monitor treatment. When analyzing ABG results, it is important to use a systematic approach. First evaluate each individual measurement, then look at the interrelationships to determine the client’s acid-base status (see Box 5–17).

ACID-BASE IMBALANCE

Acid-base disorders fall into two major categories: acidosis and alkalosis. Acidosis occurs when the hydrogen ion concentration increases above normal (pH below 7.35). Alkalosis occurs when the hydrogen ion concentration falls below normal (pH above 7.45).

Acid-base imbalances are further classified as metabolic or respiratory disorders. In metabolic disorders, the primary change is in the concentration of bicarbonate. In metabolic acidosis, the amount of bicarbonate is decreased in relation to the amount of acid in the body (Figure 5–17A). It can develop as a result of abnormal bicarbonate losses or because of excess nonvolatile acids in the body. The pH falls below 7.35 and the bicarbonate concentration is less than 22 mEq/L. Metabolic alkalosis, by contrast, occurs when there is an excess of bicarbonate in relation to the amount of hydrogen ion (Figure 5–17B). The pH is above 7.45 and the bicarbonate concentration is greater than 26 mEq/L.

In respiratory disorders, the primary change is in the concentration of carbonic acid. Respiratory acidosis occurs when carbon dioxide is retained, increasing the amount of carbonic acid in the body (Figure 5–18A). As a result, the pH falls to less than 7.35, and the PaCO\(_2\) is greater than 45 mmHg. When too much carbon dioxide is “blown off,” carbonic acid levels fall and respiratory alkalosis develops (Figure 5–18B). The pH rises to above 7.45 and the PaCO\(_2\) is less than 35 mmHg.

Acid-base disorders are further defined as primary (simple) and mixed. Primary disorders usually are due to one cause. For example, respiratory failure often causes respiratory acidosis due to retained carbon dioxide; renal failure usually causes metabolic acidosis due to retained hydrogen ion and impaired bicarbonate production. Table 5–11 summarizes primary acid-base imbalances with common causes.