All About Blood Gases
by Susan Agrawal

A blood gas is a test that helps determine respiratory function, particularly how well a child’s body is exchanging oxygen and carbon dioxide, as well as the acid/base status (pH) of the blood. While most commonly used to determine a child’s respiratory status, blood gases can also assess issues caused by metabolic or renal disorders.

Types of Blood Gas Tests

There are three basic methods of obtaining blood gases, based on how the sample is acquired:

- Arterial Blood Gas (ABG)
- Capillary Blood Gas (CBG)
- Venous Blood Gas (VBG)

Arterial Blood Gases (ABG) are the most reliable, but require blood to be obtained from an artery. Children in the NICU or PICU may have a line placed in an artery if frequent blood gases are needed. Other children will need to have an arterial stick, which is like drawing blood but from an artery instead of a vein. This can be painful and can cause considerable bleeding for many children.

Because Arterial Blood Gases can be difficult to obtain without significant pain or an arterial line, doctors often request a Capillary Blood Gas (CBG) for more routine checks of the body’s respiratory status. A CBG only requires a finger prick or heel stick, and is much less painful than an ABG. The results, however, are not as reliable as an ABG.

Venous Blood Gases (VBG) are even more unreliable, but may be required under certain circumstances when an ABG or CBG cannot be performed, as well as in some patients with central lines who need ongoing monitoring. A VBG typically provides an accurate pH level as well as a decent carbon dioxide level, but the oxygen level tends to read much lower as compared to an ABG. The results are most useful in determining trends or assessing children with milder conditions when precision is not necessary.
What is Measured?

A blood gas typically measures three things: the pH of the sample (how acidic or basic it is), the oxygen level, and the carbon dioxide level. Using these three values, as well as known factors such as body temperature and normal hemoglobin values, it is possible to calculate a variety of additional numbers.

These are the values typically measured or calculated in a blood gas:

**pH**: How acidic or basic the blood is.

**PO\textsubscript{2}**: The dissolved oxygen in the blood. PaO\textsubscript{2} is for arterial blood; PvO\textsubscript{2} is for venous blood.

**PCO\textsubscript{2}**: The dissolved carbon dioxide in the blood. PaCO\textsubscript{2} is for arterial blood; PvCO\textsubscript{2} is for venous blood.

**O\textsubscript{2} saturation (SpO\textsubscript{2})**: How much oxygen the blood is carrying as a percentage of how much it can carry.

**HCO\textsubscript{3}**: A calculation of how much bicarbonate (base) is in the blood.

**Base Excess/Deficit**: A calculation to determine the positive (excess) or negative (deficit) amount of buffer (base) that has been used up by the body.

Normal values in children over the age of two are listed in the chart below. Note that your lab may have slightly different values, and your child’s age and condition may also change the range of what is considered normal.

<table>
<thead>
<tr>
<th></th>
<th>Arterial</th>
<th>Capillary</th>
<th>Venous</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.35-7.45</td>
<td>7.35-7.45</td>
<td>7.32-7.42</td>
</tr>
<tr>
<td>PO\textsubscript{2}</td>
<td>80-100 mmHg</td>
<td>60-80 mmHg</td>
<td>24-48 mmHg</td>
</tr>
<tr>
<td>PCO\textsubscript{2}</td>
<td>35-45 mmHg</td>
<td>35-45 mmHg</td>
<td>38-52 mmHg</td>
</tr>
<tr>
<td>O\textsubscript{2} Sat</td>
<td>90-100%</td>
<td>90-100%</td>
<td>40-70%</td>
</tr>
<tr>
<td>HCO\textsubscript{3}</td>
<td>19-25 mEq/L</td>
<td>19-25 mEq/L</td>
<td>19-25 mEq/L</td>
</tr>
<tr>
<td>Base Excess/Deficit</td>
<td>-3 to +3</td>
<td>-3 to +3</td>
<td>-3 to +3</td>
</tr>
</tbody>
</table>

What Does It Mean?

Interpretation of blood gas results can be challenging, even for nurses and other medical professionals. The results must be correlated with clinical data in order to have meaning. For example, in a child with ongoing respiratory insufficiency, a blood gas may be performed periodically to ensure that the child is able to blow off enough carbon dioxide. In this instance, the most important numbers are the PCO\textsubscript{2} and HCO\textsubscript{3}. If both of these numbers are high, it suggests that the child is not adequately ridding her body of carbon dioxide.

In acutely ill children, looking at groups of numbers can suggest the cause of the illness. For example:
• A low pH and high PCO₂ suggests an acute respiratory acidosis (too much acidity of the blood caused by a respiratory issue), such as from not breathing adequately.
• A low pH with a low HCO₃ and normal PCO₂ suggests an acute metabolic acidosis (too much acidity of the blood caused by a metabolic issue), such as severe dehydration.
• A high pH and a low PCO₂ suggests an acute respiratory alkalosis (too little acidity of the blood caused by a respiratory issue), such as in hyperventilation from asthma.
• A high pH with a high HCO₃ and normal PCO₂ suggests an acute metabolic alkalosis (too little acidity of the blood caused by a metabolic issue), such as with vomiting.

It is also possible to have chronic problems with respiratory or metabolic acidosis, or respiratory or metabolic alkalosis. A child can also have a mixed state, such as a metabolic acidosis combined with a respiratory alkalosis, which can be seen in severe asthma.

**Follow the Trends**

Acid-base physiology is complicated to understand and interpret. Your best bet is to have a basic understanding of what each element means and then follow your own child’s trends. Good luck!