

# Does Every Blood Gas Need Co-oximetry?

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Arterial Blood Gas (ABG) analysis is used to assess both the acid-base balance and oxygenation of a patient's condition. In an effort to assess the oxygenation of a patient, there are a minimum of three (3) basic tests needed. They include the partial pressure of oxygen ( $PO_2$ ), the oxygen saturation ( $SO_2$ ) of hemoglobin, and the total hemoglobin (tHb). It is the combination of the tests and others that provide clinicians with an accurate understanding of a patient's oxygenation status.

Whole blood is comprised of both plasma and hemoglobin. Oxygen diffuses into the plasma and can be measured using the partial pressure of oxygen ( $PO_2$ ). The  $PO_2$  often represents a significant understanding of the alveolar diffusion of oxygen into the blood stream. The  $PO_2$  is usually measured on a blood gas analyzer with the pH and partial pressure of carbon dioxide ( $PCO_2$ ). Once oxygen diffuses into the plasma, it can bind to hemoglobin for transportation to the cells. The  $O_2Hb$  represents the amount of oxygen that is bound to hemoglobin for transport to diffuse through the cellular walls and into the cell. The  $O_2Hb$  can only be measured using wave lengths of light and is preferred on a co-oximeter that tests for hemoglobin.

What is co-oximetry? Co-oximetry is not a test but a methodology, also known as spectrophotometry. Co-oximetry provides a means of measuring several different tests using light emission and absorption based on Lambert-Beer's law. In an ABG assessment, co-oximetry is used to determine the total hemoglobin (tHb), hemoglobin derivatives, and sometimes bilirubin test values. Hemoglobin derivatives are commonly known as Oxyhemoglobin ( $O_2Hb$ ), Deoxyhemoglobin (HHb) or Reduced Hemoglobin (rHb), Methemoglobin (MetHb), and Carboxyhemoglobin (COHb). Occasionally, there is a clinical need to evaluate other hemoglobin derivatives including Sulfhemoglobin (SulfHb) or Fetal Hemoglobin (HbF). These parameters are a result of using co-oximetry to identify the test value for clinical assessment.

Oxygen saturation can also be measured by co-oximetry. However, the means used to determine oxygen saturation vary. Oxygen saturation is a percentage value indicating the amount of hemoglobin that is saturated with oxygen. There are three (3) different ways to determine oxygen saturation. They are the fractional oxygen saturation, the function oxygen saturation, and the calculated oxygen saturation measurements.

The first method of determining oxygen saturation is by measuring the  $O_2Hb$  and comparing it to all the hemoglobin measured. This method is common for fractional oxygen saturation measurements ( $FO_2Hb$ ) from co-oximetry. The equation for which is:  $FO_2Hb = O_2Hb / 100$

The second method of determining oxygen saturation is by measuring the  $O_2Hb$  and rHb/HHb only. This is referred to as functional hemoglobin saturation and can only be determined by using co-oximetry. This allows clinicians to assess how much of the hemoglobin capable of carrying oxygen is actually saturated with oxygen molecules. The equation for this measurement is:  $SO_2 = O_2Hb / O_2Hb + HHb$ .

The third method of determining oxygen saturations is by calculating the oxygen saturation ( $SO_2c$ ) using an equation or algorithm using a measured  $PO_2$ , pH,  $PCO_2$ , and a calculated/default hemoglobin. The challenge with the calculated oxygen saturation is that clinicians must often assume normal hemoglobin values in their critically ill patients that receive a blood gas and that there are no other inhibitors such as MetHb or COHb.

When comparing the three (3) different means of obtaining the oxygen saturation measurement, only  $O_2Hb$  and  $SO_2$  measured by co-oximeter provides direct measurement information to assess the oxygenation of hemoglobin. The use of  $SO_2c$  (calculated oxygen saturation) restricts the clinician's ability to make a true determination of a patient's oxygenation status by only assessing the oxygenation of the blood plasma and often assuming normal or default hemoglobin values in a patient. Therefore, in order to make an accurate assessment of a patient's oxygenation status, the  $PO_2$  measurement is needed in conjunction with the  $O_2Hb$  measurement from a co-oximeter.

Understanding the intent of an ABG is to measure both the acid-base balance and the oxygenation of a patient is fairly simple. However it is important for clinicians to understand the need to measure both the  $PO_2$  and  $O_2Hb$  (by co-oximetry) in order to perform an accurate patient assessment of oxygenation. Once clinicians understand the need for co-oximetry with all ABG tests, the accuracy of a patient's oxygenation will be assured.

## References

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