

Blood Gas Analysis



Agilent Technologies

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Blood Gases

Blood gas analysis provides information about the patient's acid-base balance, metabolic status, and ventilatory status.

Definitions

- pH:** The negative logarithm of the concentration of H⁺ ions. This value reflects the acid-base status of the blood.
- Pco₂:** Partial pressure exerted by the carbon dioxide molecules in the blood. CO₂ levels are controlled by the ventilatory system.
- Po₂:** Partial pressure of oxygen molecules dissolved in the blood.
- HCO₃⁻:** Concentration of the bicarbonate ions in the blood. HCO₃⁻ is a base that is excreted or retained by the kidneys as necessary.
- So₂:** Percentage of hemoglobin saturated with O₂.
- O₂ content:** Calculated parameter that reflects the total amount of O₂ in the blood. Approximately 97% of O₂ is bound to hemoglobin.
- Base excess/deficit:** Calculated parameter that indicates the number (positive or negative) of buffering ions in the blood. Buffering ions can be HCO₃⁻, hemoglobin, proteins, and phosphates. Base excess is useful for detecting metabolic disorders: negative values indicate metabolic acidosis, whereas positive values indicate metabolic alkalosis or compensated respiratory acidosis.
- Acidemia:** Condition when blood has a pH < 7.35.
- Acidosis:** Process that causes acidemia.
- Alkalemia:** Condition when blood has a pH > 7.45.
- Alkalosis:** Process that causes alkalemia.

- Hypoxia:** Reduced oxygen levels in air, blood, or tissue.
- Hypoxemia:** Reduced oxygen content in blood.
- A-a Po₂ gradient:** Calculated parameter that indicates difference between alveolar and arterial O₂ levels.

Oxygenation Status

- Arterial oxygenation is usually considered compromised when
 - SaO₂ < 90%
 - PaO₂ < 60 mm Hg
 Po₂ is affected by patient's age and body temperature, barometric pressure, and fraction of inspired oxygen (Fio₂).
- If a patient is receiving supplemental oxygen, PaO₂ is interpreted in relation to the Fio₂ delivery.
 - PaO₂/Fio₂ normal range is 286-350 (200 may be acceptable in some clinical situations).
 - When Po₂ > 100 mm Hg, Fio₂ should be reduced.
- A-a Po₂ gradient is also a measure of oxygenation.
 - Normal = 10-15 mm Hg
 - Increases with increases in oxygen delivery (Fio₂)
 - Increases with increases in intrapulmonary shunting
- PvO₂ and SvO₂, indicators of venous oxygenation, are important guides for evaluating tissue oxygenation.

Normal Mixed Venous Blood Gas Values at Sea Level	
pH	7.31 - 7.41
Po ₂ , mm Hg	35 - 40
Pco ₂ , mm Hg	41 - 51
SvO ₂ , %	70 - 75
HCO ₃ ⁻ , mmol/L	22 - 26
Base excess, mmol/L	-2 to +2

Mixed Imbalances		
Blood Gas Result	Coexisting Respiratory and Metabolic Acidosis	Coexisting Respiratory and Metabolic Alkalosis
pH	<7.34	>7.45
Paco ₂ , mm Hg	>45	<35
HCO ₃ ⁻ , mmol/L	<21	>26

Analyzing Results of Arterial Blood Gas Analysis					
	pH	Paco₂, mm Hg	HCO₃⁻, mmol/L	Compensation	Common Causes
Respiratory acidosis	<7.35	>45	HCO ₃ ⁻ >26 mmol/L		Obstructive lung disease, head trauma, oversedation, general anesthesia, inappropriate settings for mechanical ventilation, Guillain Barre syndrome
Respiratory alkalosis	>7.45	<35	HCO ₃ ⁻ <21 mmol/L		Hypoxemia, nervousness/anxiety, low hemoglobin level, pulmonary embolus, bacteremia, interstitial lung disease, brain stem tumors, response to metabolic acidosis, respiratory stimulant drugs, excessive mechanical ventilation
Metabolic acidosis	<7.35		<21	Paco ₂ <35 mm Hg	Diabetic ketoacidosis, starvation, lactic acidosis, renal failure, uremia, diarrhea, pancreatic drainage
Metabolic alkalosis	>7.45		>28	Paco ₂ >45 mm Hg	Vomiting, prolonged nasogastric suctioning, diuretic therapy, hypokalemia, massive blood transfusions containing citrate, bicarbonate administration, Cushing syndrome

Normal Arterial Blood Gas Values at Sea Level					
	Adult	Elderly (<60 years old)	Child	Critical Values	
pH	7.35 - 7.45	7.35 - 7.45	2 mo - 2 yr: 7.34 - 7.46 >2 yr: 7.35 - 7.45	<7.25, >7.55	
Paco ₂ , mm Hg	35 - 45	35 - 45	<2 yr: 26 - 41 >2 yr: 35 - 45	<20, >60	
HCO ₃ ⁻ , mmol/L	21 - 28	21 - 28	21 - 28	<15, >40	
Pao ₂ , mm Hg	80 - 100	100 - (age / 3)	80 - 100	<40	
SaO ₂ , %	95 - 100	95	95 - 100	<76	
O ₂ content, %	15 - 22	15 - 22	15 - 22		
Base excess, mmol/L	-2 to +2	-2 to +2	-2 to +2	±3	