

Hemodynamics and ABGs

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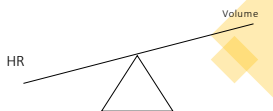
Basic Hemodynamics – Cardiac Output

For the body to function properly, the heart needs to pump blood at a sufficient rate to maintain an adequate and continuous supply of oxygen and other nutrients to the brain and other vital organs.

Cardiac output is the amount of blood your heart pumps each minute.

Cardiac output = stroke volume x heart rate

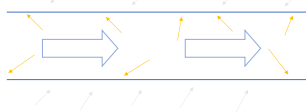
- Stroke volume = amount of blood your heart pumps each time it beats
- Heart rate = number of times your heart beats per minute



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Basic Hemodynamics – Blood Pressure

$$BP = CO \times SVR$$

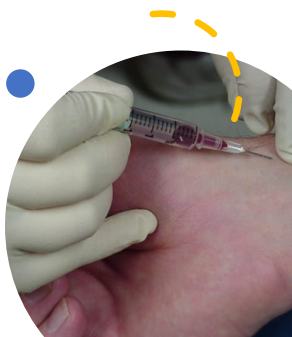


Systemic Vascular Resistance = resistance to the flow of blood through the body's blood vessels. It increases as vessels constrict (norepinephrine) and decreases when vessels dilate (sepsis).

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**Invasive Monitoring:
Arterial Blood Gas**

- Measures the effectiveness of the "Blood Movement"
 - Tests for the lungs, heart and kidneys
 - Measures oxygen and carbon dioxide in your blood



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ABG Worksheet

Normal Values	Acidosis	Alkalosis	R	R
pH: PaCO2: HCO3: PaO2:			O M E	O M E
Respiratory Component				
Metabolic Component				

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ABG Worksheet

Normal Values	Acidosis	Alkalosis	R	R
pH: 7.35 – 7.45 PaCO2: HCO3: PaO2:			O M E	O M E
Respiratory Component				
Metabolic Component				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO2: 35 – 45 HCO3: PaO2:	Acidosis	Alkalosis	R O M E	R O M E
Respiratory Component				
Metabolic Component				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO2: 35 – 45 HCO3: 22 – 26 PaO2:	Acidosis	Alkalosis	R O M E	R O M E
Respiratory Component				
Metabolic Component				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO2: 35 – 45 HCO3: 22 – 26 PaO2: 80 – 100	Acidosis	Alkalosis	R O M E	R O M E
Respiratory Component				
Metabolic Component				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis	Alkalosis	R O M E	R O M E
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis				
Metabolic Component				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis	Alkalosis	R O M E	R O M E
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis	Alkalosis	R O M E	R O M E
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis	Alkalosis	R O M E	R O M E
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	↓ pH < 7.35	Alkalosis	R O M E	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	↓ pH < 7.35 ↑ PaCO ₂ > 45	Alkalosis	R O M E	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis	R O M E	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45	R O M E	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35	R O M E	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	R O M E	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35	Respiratory Opposite Metabolic Equal	
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly	↓ HCO ₃ < 22	↑ HCO ₃ > 26	
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35	Respiratory Opposite Metabolic Equal	pH 7.21 PaCO ₂ 37 HCO ₃ 18
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly	↓ HCO ₃ < 22	↑ HCO ₃ > 26	
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35	Respiratory Opposite Metabolic Equal	pH 7.21 ↓ PaCO ₂ 37 HCO ₃ 18
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly	↓ HCO ₃ < 22	↑ HCO ₃ > 26	
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.21 ↓ PaCO ₂ 37 Normal HCO ₃ 18
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly			
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.21 ↓ PaCO ₂ 37 Normal HCO ₃ 18 ↓
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly			
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.21 ↓ PaCO ₂ 37 Normal HCO ₃ 18 ↓ Metabolic Acidosis
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly			
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.28 PaCO ₂ 60 HCO ₃ 24
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly			
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.28 ↓ PaCO ₂ 60 HCO ₃ 24
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly			
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.28 ↓ PaCO ₂ 60 ↑ HCO ₃ 24
	Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly			
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.28 ↓ PaCO ₂ 60 ↑ HCO ₃ 24 Normal
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.28 ↓ PaCO ₂ 60 ↑ HCO ₃ 24 Normal Respiratory Acidosis
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.49 PaCO ₂ 45 HCO ₃ 28
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.49 ↑ PaCO ₂ 45 HCO ₃ 28
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.49 ↑ PaCO ₂ 45 Normal HCO ₃ 28
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.49 ↑ PaCO ₂ 45 Normal HCO ₃ 28 ↑
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				

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ABG Worksheet

Normal Values pH: 7.35 – 7.45 PaCO ₂ : 35 – 45 HCO ₃ : 22 – 26 PaO ₂ : 80 – 100	Acidosis ↓ pH < 7.35 ↑ PaCO ₂ > 45 ↓ HCO ₃ < 22	Alkalosis ↑ pH > 7.45 ↓ PaCO ₂ < 35 ↑ HCO ₃ > 26	Respiratory Opposite Metabolic Equal	pH 7.49 ↑ PaCO ₂ 45 Normal HCO ₃ 28 ↑ Metabolic Alkalosis
Respiratory Component PaCO ₂ ↑ Acidosis ↓ Alkalosis Changes quickly				
Metabolic Component HCO ₃ ↑ Alkalosis ↓ Acidosis Changes slower				
