The Critical Care Equation

(The Oxygen Flux Equation)

Definitions

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Tissue Hypoxia

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Tissue Hypoxia	Inadequate cellular respiration

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Hypoxia	

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Tissue Hypoxia	Inadequate cellular respiration
Hypoxia	Low arterial oxygenation

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Tissue Hypoxia	Inadequate cellular respiration
Hypoxia	Low arterial oxygenation
Shock	

Definitions

Tissue Hypoxia	Inadequate cellular respiration
Hypoxia	Low arterial oxygenation
Shock	Inadequate perfusion of the tissues

Types of Tissue Hypoxia

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Stagnant

Types of Tissue Hypoxia

Stagnant	Low cardiac output

Types of Tissue Hypoxia

Stagnant	Low cardiac output
Hypoxic	

Types of Tissue Hypoxia

Stagnant	Low cardiac output
Hypoxic	Low arterial oxygenation

Types of Tissue Hypoxia

Stagnant	Low cardiac output
Hypoxic	Low arterial oxygenation
Anaemic	

Types of Tissue Hypoxia

Stagnant	Low cardiac output
Hypoxic	Low arterial oxygenation
Anaemic	Low effective haemoglobin concentration

Types of Tissue Hypoxia

Stagnant	Low cardiac output
Hypoxic	Low arterial oxygenation
Anaemic	Low effective haemoglobin concentration
Cytotoxic	

Types of Tissue Hypoxia

Stagnant	Low cardiac output
Hypoxic	Low arterial oxygenation
Anaemic	Low effective haemoglobin concentration
Cytotoxic	Mitochondrial dysfunction

Oxygen Delivery

Oxygen Delivery

$$O_2\ Flux \quad = \quad Q \quad . \quad [O_2]_{blood}$$

Oxygen Delivery

$$Q = SV \cdot HR$$

$$O_2\ Flux = Q \cdot [O_2]_{blood}$$

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$$O_2\ Flux = Q \cdot [O_2]_{blood}$$

$$[O_2]_{blood} = [O_2]_{Haemoglobin} \cdot [O_2]_{Plasma}$$

Oxygen Delivery

$$Q = SV \cdot HR$$

$$O_2\ Flux = Q \cdot [O_2]_{blood}$$

$$[O_2]_{blood} = [O_2]_{Haemoglobin} \cdot [O_2]_{Plasma}$$

$$[O_2]_{Haemoglobin} = [Hb] \cdot SatHb \cdot 1.34\ ml/g$$

Oxygen Delivery

$$Q = SV \cdot HR$$

$$O_2\ Flux = Q \cdot [O_2]_{blood}$$

$$[O_2]_{blood} = [O_2]_{Haemoglobin} \cdot [O_2]_{Plasma}$$

$$[O_2]_{Haemoglobin} = [Hb] \cdot SatHb \cdot 1.34\ ml/g$$

$$[O_2]_{Plasma} = Pa\ O_2 \cdot 0.03ml/L$$

Oxygen Delivery

$$O_2\ Flux\ =\ Q\ .\ \left([Hb]\ .\ SatHb\ .\ 1.34\ ml/g\right)\ +\ \left(Pa\ O_2\ .\ 0.03ml/L\right)$$

Oxygen Delivery

Shock

$$O_2\ Flux = Q \cdot ([Hb] \cdot SatHb \cdot 1.34\ ml/g) + (Pa\ O_2 \cdot 0.03ml/L)$$

Types of Shock

Types of Shock

Types of Shock

Obstructive

Types of Shock

Obstructive

Cardiogenic

Types of Shock

Obstructive

Cardiogenic

Hypovolaemic

Types of Shock

Obstructive

Cardiogenic

Hypovolaemic

Redistributive

Types of Shock

	JVP	Perfusion
Obstructive		
Cardiogenic		
Hypovolaemic		
Redistributive		

Types of Shock

	JVP	Perfusion
Obstructive	↑↑	↓
Cardiogenic		
Hypovolaemic		
Redistributive		

Types of Shock

	JVP	Perfusion
Obstructive	↑↑	↓
Cardiogenic	↑	↓
Hypovolaemic		
Redistributive		

Types of Shock

	JVP	Perfusion
Obstructive	↑↑	↓
Cardiogenic	↑	↓
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Redistributive		

Types of Shock

	JVP	Perfusion
Obstructive	↑↑	↓
Cardiogenic	↑	↓
Hypovolaemic	↓	↓
Redistributive	↓	↑

Oxygen Delivery

Shock

$$O_2\ Flux = Q \cdot ([Hb] \cdot SatHb \cdot 1.34\ ml/mg) + (Pa\ O_2 \cdot 0.03ml/L)$$

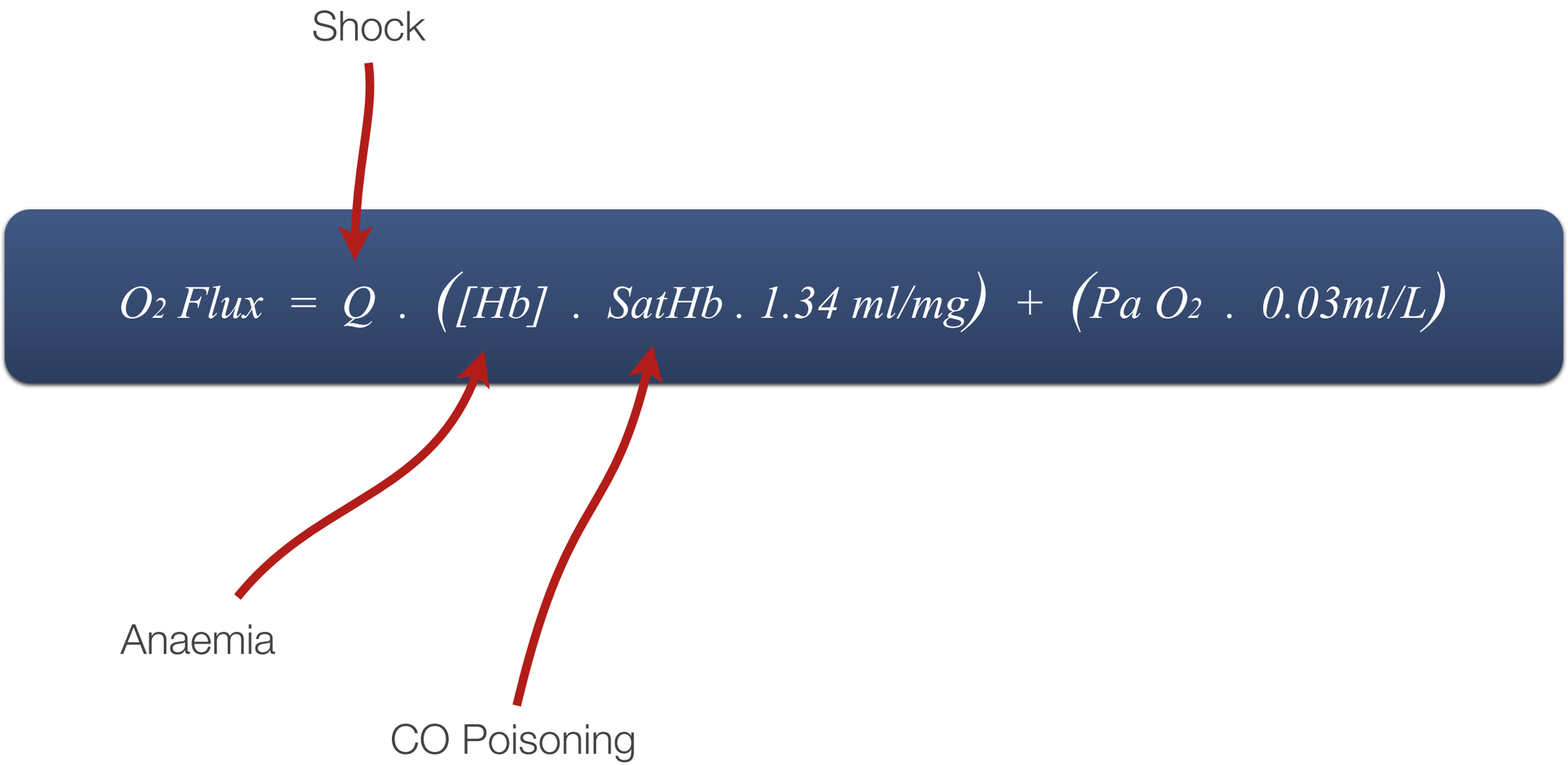
Oxygen Delivery

Shock

$$O_2\ Flux = Q\ .\ ([Hb]\ .\ SatHb\ .\ 1.34\ ml/mg) + (Pa\ O_2\ .\ 0.03ml/L)$$

Anaemia

Oxygen Delivery



Oxygen Delivery

Shock

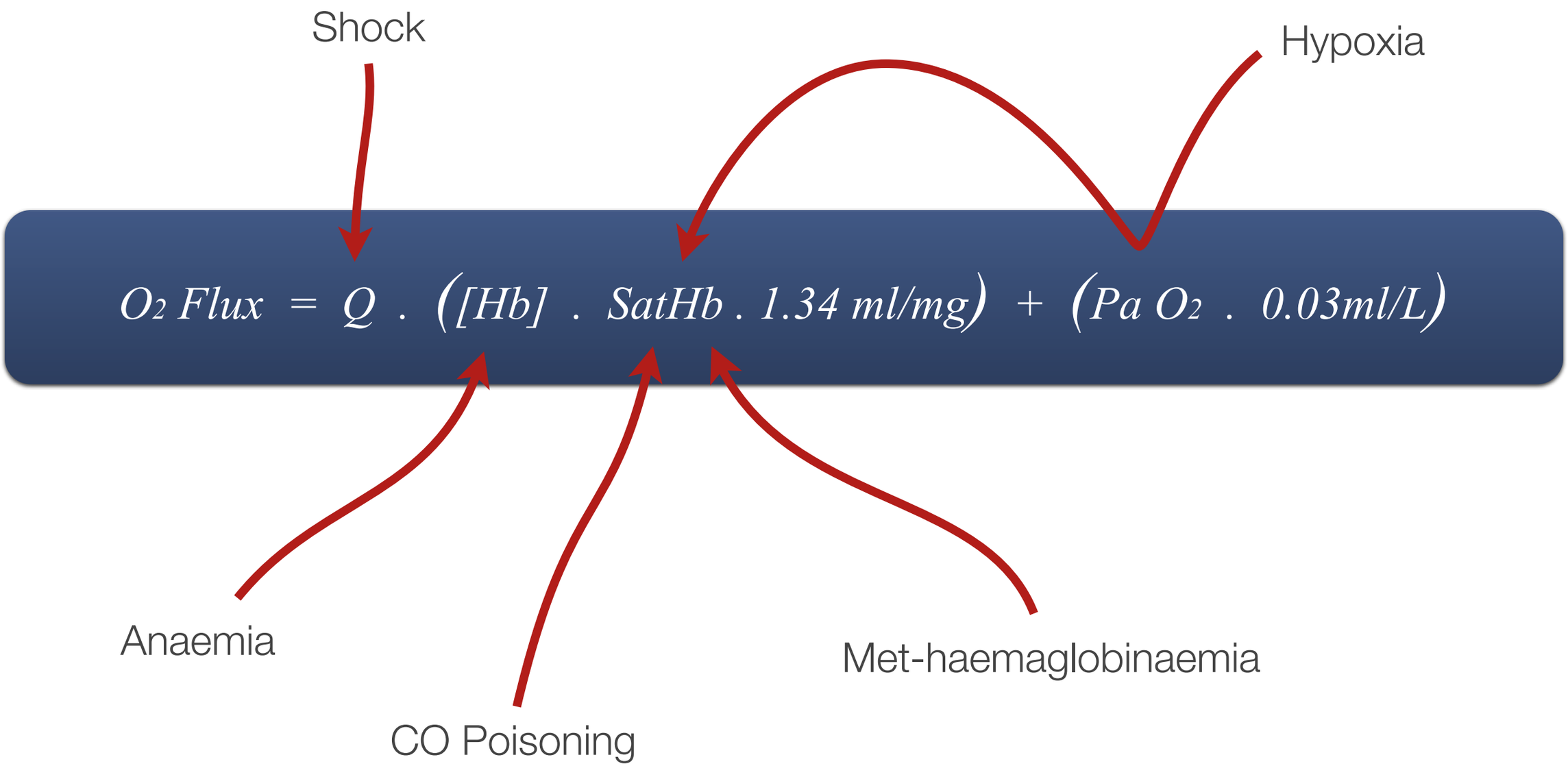
$$O_2\ Flux = Q\ .\ ([Hb]\ .\ SatHb\ .\ 1.34\ ml/mg) + (Pa\ O_2\ .\ 0.03ml/L)$$

Anaemia

CO Poisoning

Met-haemaglobinaemia

Oxygen Delivery



Causes of Hypoxia

Causes of Hypoxia

1. ↓ FiO_2

Causes of Hypoxia

1. ↓ FiO_2
2. Hypoventilation

Causes of Hypoxia

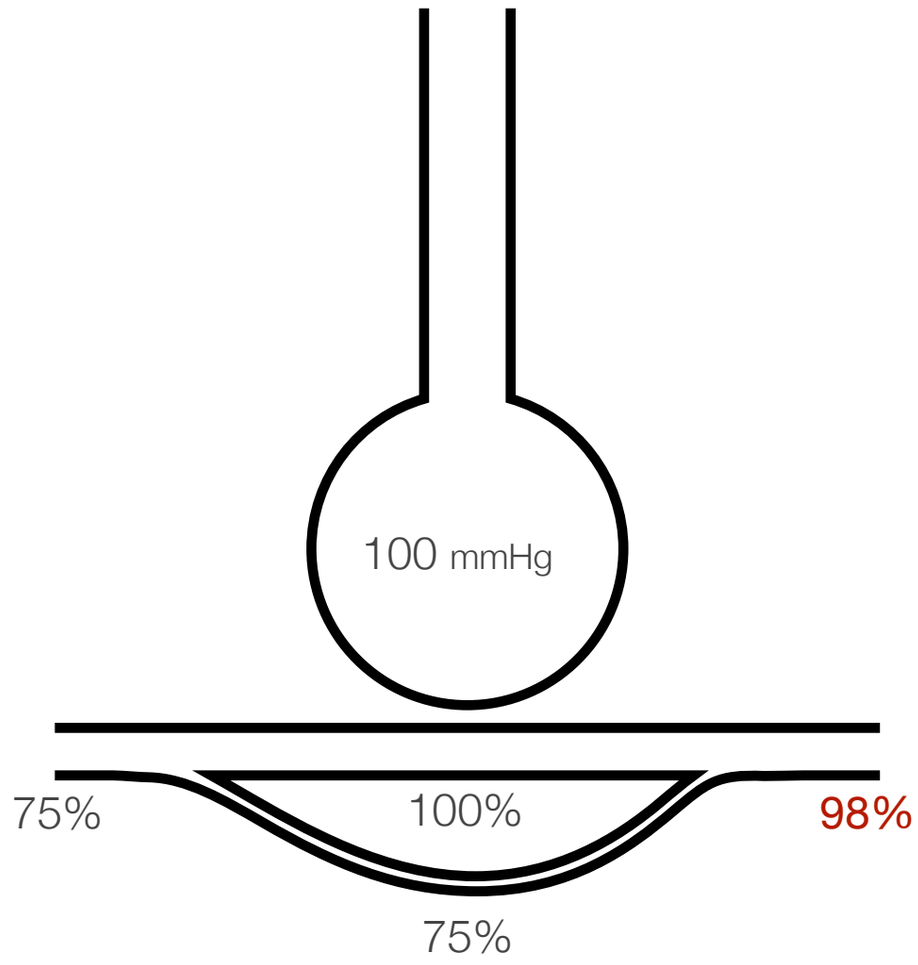
1. ↓ FiO_2
2. Hypoventilation
3. Shunt

Causes of Hypoxia

1. ↓ FiO_2
2. Hypoventilation
3. Shunt

Normal Oxygen Exchange

O_2

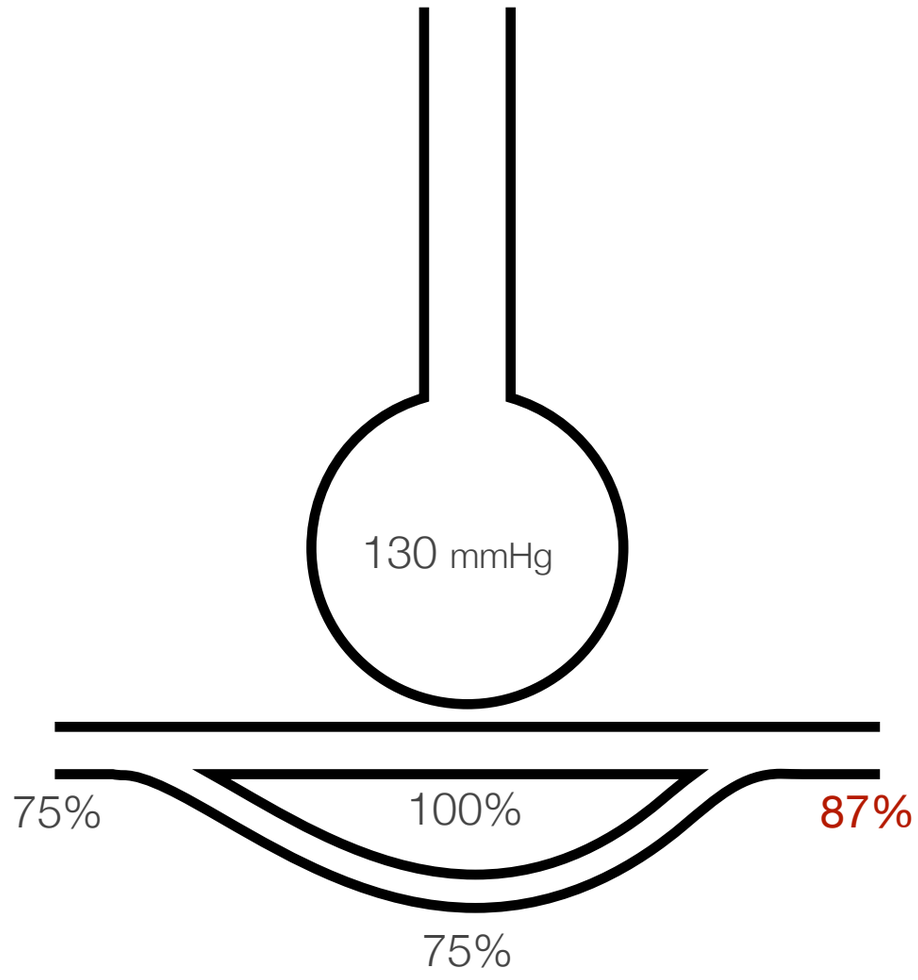


Venous

Arterial

Shunt

O_2

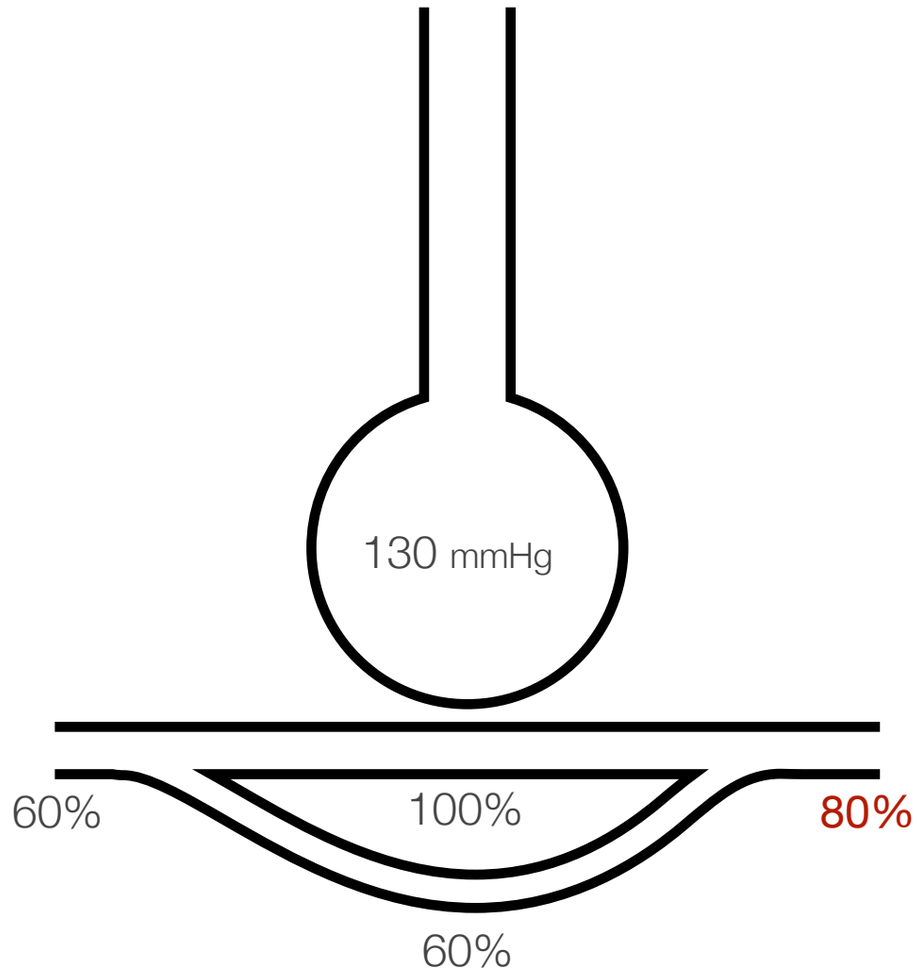


Venous

Arterial

Shunt

O_2



Venous

Arterial