

Pneumothorax



Inspiration moves the ribcage out and the diaphragm down, creating a negative pressure in the pleural space. This negative pressure pulls at and inflates the lungs.

If air is allowed to enter the pleural space from the lung or through the ribcage during inspiration, the lung does not inflate. This is pneumothorax.

Bilateral pneumothorax is quickly fatal if not attended to immediately. Unilateral pneumothorax is more interesting physiologically and is the topic of this exercise.

Unilateral pneumothorax has three main components.

The negative pleural pressure is lost on the ipsilateral side. This pressure tends to hold open the pulmonary blood vessels and when it is lost the pulmonary vascular resistance increases and cardiac output decreases (Ann. Thoracic Surg., 1993).

The loss of negative pleural pressure and increased pulmonary vascular resistance on the ipsilateral side reroutes some pulmonary blood flow the contralateral side where relatively normal lung inflation continues (Carvalho, *et.al.*, 1996). This is beneficial.

Thirdly, pulmonary blood flowing though the ipsilateral side is not oxygenated due to the absence of lung inflation. This constitutes a massive right-to-left pulmonary shunt (Rutherford, 1968). Severe arterial hypoxia is the immediate result.

You can view these consequences of pneumothorax in the exercise that follows.



Before undertaking the exercise, recall that arterial hypoxia stimulates ventilation. Will this be beneficial? Would administering 100% O₂ help? What will be the body's long-term response to this condition?

The Pneumothorax Protocol

Click **Restart** to reestablish initial conditions and then record control values.

Go to **Thorax** and click open the right hemithorax. Record the acute hemodynamic effects of this stenosis. Advance time and record data. Look for evidence of compensation.

Cardiac Output (mL/Min)
Stroke Volume (mL)
Heart Rate (Beats/Min)

Arterial pO₂ (mmHg)
Blood Volume (mL)

Total Ventilation (L/Min)
Ventilation Rate (/Min)
Tidal Volume (mL)

Right Lung Inflation (x Normal)

Left Lung Inflation (x Normal)

Respiratory Drive (x Normal)

Time	Control	Acute	1 Week
Cardiac Output			
Heart Rate			
Stroke Volume			
Arterial pO ₂			
Blood Volume			
Total Ventilation			
Ventilation Rate			
Tidal Volume			
Right Inflation			
Left Inflation			
Respiratory Drive			



References

Carvalho, P., J. Hilderbrandt and N.B. Charan. Changes in bronchial and pulmonary artery blood flow with progressive tension pneumothorax. *J. Appl. Physiol.* 81:1664, 1996.

Ann. Thoracic Surg. 55:1379, 1993.

Rutherford. *J. Trauma* 8:212, 1968.

