

# A Friend in Need Is a Friend Indeed: A Case Study on Human Respiratory Physiology

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When Charles returned to his apartment at 5 PM in the evening, he turned on his old kerosene-fueled space heater. It had been a cold day in late spring and his third floor apartment was chilly. After spending an hour fixing dinner, he ate while watching the evening news on TV. He noticed that his vision became progressively blurred. When he got up to go to the kitchen, he felt lightheaded and unsteady. Entering the kitchen, he became very disoriented and passed out. The next thing he remembered was waking up in the intensive care unit of the hospital. Some friends who had stopped by about 7 PM had found Charles unconscious on the kitchen floor. They had called an ambulance, which had rushed Charles, still unconscious, to the hospital.

An arterial blood sample drawn when he first arrived at the hospital showed the following values:

$P_{N_2}$	$P_{O_2}$	$P_{CO_2}$	$P_{CO}$
573 mm Hg	95 mm Hg	40 mm Hg	0.4 mm Hg

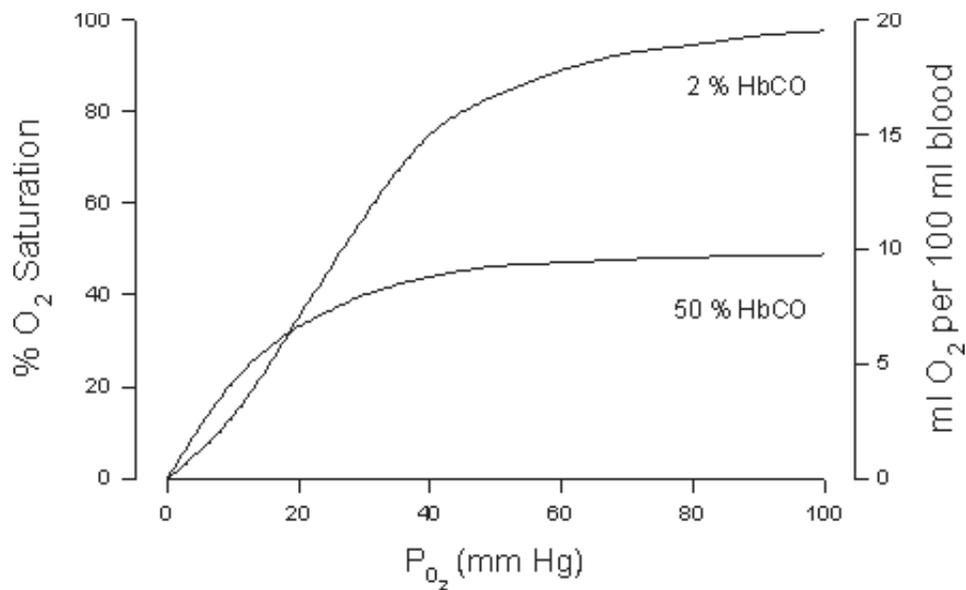
## Questions

- The blood gas measurements show abnormalities in the partial pressure(s) of what gas(es)?
  - $N_2$ ,  $O_2$  and CO
  - CO and  $CO_2$
  - CO alone
  - $N_2$  and CO
  - $O_2$  and CO
- A measurement of Charles' blood reveals that the  $O_2$  content is low (50% of normal) and hemoglobin is 50% saturated with CO (50% HbCO).

The oxygen-hemoglobin saturation curve in Charles' blood (50% HbCO) and under normal conditions (2% HbCO) is shown on the next page.  $CO_2$  binding to hemoglobin is normal in both instances.

What is the approximate % saturation of hemoglobin by  $O_2$  in normal arterial blood?

- 100%
- 97%
- 75%
- 50%
- 35%



3. What is the maximum amount of O<sub>2</sub> (ml/100 ml blood) that can be carried in Charles' arterial blood?
  - a. 2 ml/100 ml
  - b. 5 ml/100 ml
  - c. 10 ml/100 ml
  - d. 15 ml/100 ml
  - e. 20 ml/100 ml
4. CO enhances the Bohr effect. This means that CO will cause a more pronounced shift of the hemoglobin oxygen saturation curve to the:
  - a. right
  - b. left
5. If the partial pressure of O<sub>2</sub> in the body tissues is 20 mm Hg, what is the best estimate of the amount of O<sub>2</sub> (ml/100ml) that can be released from Charles' blood as it circulates in his systemic capillaries?
  - a. <1 ml /100 ml
  - b. 1 ml /100 ml
  - c. 2.5 ml /100 ml
  - d. 5 ml /100 ml
  - e. 10 ml /100 ml
6. In Charles' blood, the partial pressure of CO in the blood is far lower than the partial pressure of O<sub>2</sub>, yet the percent saturation of hemoglobin by each gas is equal. This result indicates that the affinity of hemoglobin for CO is approximately how many times greater as compared to O<sub>2</sub>?
  - a. 38
  - b. 100
  - c. 238
  - d. 708
  - e. 1783

7. Would you expect Charles' disorder to be accompanied by chemoreceptor-mediated hyperventilation?
  - a. Yes, since the % oxygen saturation of hemoglobin in his blood is decreased
  - b. Yes, since CO acts as a CNS neurotransmitter and central chemoreceptors are located in the brain
  - c. Yes, since elevated partial pressure of CO is detected by peripheral chemoreceptors in carotid and aortic bodies
  - d. No, since the partial pressure of O<sub>2</sub> in his blood is normal
  - e. No, since CO is unable to diffuse across the blood-brain barrier
8. Fundamentally, Charles' condition is a problem of:
  - a. pulmonary ventilation
  - b. diffusion across the respiratory membrane between the alveolar air space and the alveolar capillaries
  - c. transport of gases between the alveolar capillaries and capillary beds in other tissues
  - d. exchange of dissolved gases between the blood and the interstitial fluid in peripheral tissues
  - e. absorption of oxygen and release of carbon dioxide by cells in the peripheral tissues
9. With regard to the physiology of external respiration, Charles' disorder is most analogous to:
  - a. barbiturate-induced hypoventilation
  - b. altitude sickness
  - c. emphysema
  - d. acute hemorrhagic anemia
10. Which of the following is NOT an appropriate component of an aggressive treatment plan for Charles' disorder?
  - a. administration of a breathing gas mixture with a high percentage of oxygen
  - b. alkalization of the blood (increase the pH)
  - c. partial blood replacement with normal, compatible whole blood
  - d. administration of a breathing gas mixture with elevated levels of carbon dioxide

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