How Inhaled Carbon Dioxide Affects the Body – Fact Sheet

Normally, humans breathe in air that is approximately 20.95% oxygen, 78.09% nitrogen, 0.93% argon, and 0.04% (400 ppm) of carbon dioxide. Like CO_2, oxygen also dissolves in the lungs and is transported to the blood via diffusion across the lung tissue (alveoli). Once in the blood, oxygen is carried throughout the body by the arteries, and is used in cell metabolism throughout the body.

Carbon dioxide is given off as a by-product of cell metabolism and is carried by the blood through the venous system (veins) to the lungs. Here it is exhaled. The concentration of CO_2 in each breath is ~3.8%, and the "average" person produces approximately two pounds of carbon dioxide each day. More CO_2 is given off by strenuous activity.

Hypercapnia, hypercarbia, or hypercapnea, is the physiological term for the condition of, and the body's response to, excessive carbon dioxide. When CO_2 is breathed into the lungs, it dissolves in the water there, diffuses across the alveolar-capillary membrane, and enters the bloodstream. As it combines with water, it forms carbonic acid, making the blood acidic. So CO_2 in the bloodstream lowers the blood pH.

When CO_2 levels become excessive, a condition known as acidosis occurs. This is defined as the pH of the blood becoming less than 7.35. The body maintains the balance mainly by using bicarbonate ions in the blood. As the body responds to neutralize this condition, an electrolyte imbalance – an increase of plasma chloride, potassium, calcium and sodium, can occur. In the blood stream, CO_2 concentration is also controlled by reversible reactions with two major blood components, plasma proteins and hemoglobin.

In addition, the body uses other specific mechanisms to compensate for the excess carbon dioxide. Breathing rate and breathing volume increase, the blood pressure increases, the heart rate increases, and kidney bicarbonate production (in order to buffer the effects of blood acidosis), occur. Blood vessels in the extremities constrict, restricting blood flow to these body parts. At the same time, arteries in the brain, spinal cord, and heart dilate, so that more blood flows is diverted to maintain the function of these critical organs.

When there is exposure to very high levels of CO_2, in excess of 5% (50,000 ppm), the body's compensatory mechanisms can become overwhelmed, and the central nervous system (brain and spinal cord) functions are depressed, then fail. Death soon follows.

Hyperventilation (rapid breathing) can cause too little CO_2 and result in alkalosis (pH blood becomes elevated).

People at high altitudes that are not acclimated (pilots without supplemental oxygen, travelers to high altitudes), because there is less available oxygen to breathe (lower partial pressure of oxygen because the air is "thinner"), can become unconscious due to lack of oxygen without ever having a sensation of "air hunger".

Fortunately, during the past decade, great strides have been made in developing accurate, rugged, and dependable carbon dioxide sensors at a reasonable cost. These sensors can now be part of a multi-gas monitor, such as those used for confined space entry, be a single gas monitor that is hand-held or worn by the worker, or be installed in a production area to detect high levels of CO_2. Industry has embraced this technology, using them as a routine part of production work, and trained workers to use them.