

Carbon Monoxide Poisoning

CO Quick Facts:

- A carboxynemoglobin (COHb) saturation of 25 % is sufficient to cause headache, confusion, dizziness, some visual disturbance, and possibly fainting spells.
- A COHb saturation of 45% is sufficient to produce vomiting and unconsciousness.
- A COHb saturation of 60% is sufficient to cause death.
- Low CO environments can still be extremely dangerous if exposed for a period of hours.
- COHb has a "half-life" of more than five hours for a patient breathing fresh air.
- COHb has a "half-life" of 1.5 to 2.5 hours with 100% oxygen therapy.
- COHb has a "half-life" of less than a half-hour when treated by hyperbaric chamber.
- A person can still test positive for CO even after 12 hours of 100% oxygen therapy.

CO Basics:

When carbon monoxide is inhaled, the CO combines with the hemoglobin to form "carboxyhemoglobin" (COHb). The COHb bond is over 200 times stronger than oxygen's bond with the hemoglobin. Thus, the CO effectively puts the hemoglobin "out of commission" and deprives the body of the oxygen it needs to survive. The strong COHb bond explains why even very tiny concentrations of carbon monoxide can poison a victim slowly over a period of several hours, and why it may take a long, long time for the body to eliminate CO buildups from the bloodstream.

How long? According to an authoritative medical text (Rosen's Emergency Medicine, 3rd Ed., 1992), COHb has a "half-life" of more than five hours for a patient breathing fresh air. In other words, if you find yourself with a COHb saturation of 40%, your COHb level can be expected to drop to about 20% after five or six hours, to 10% after another five or six hours, and so forth. If you're taken to the emergency room and they put you on oxygen therapy, the half-life drops to 1.5 to 2.5 hours (depending on whether the docs put you on a ventilator or just use a face mask). In extreme cases of CO poisoning, you may be rushed to a large medical center and put into a hyperbaric chamber with pure oxygen at three times normal atmospheric pressure, which reduces the half-life to under a half-hour.

According to the FAA Civil Aeromedical Institute, cigarette smoking will normally produce a COHb saturation of 3% to 10%. Consequently smokers are far more vulnerable to CO poisoning, since they're already in a partially-poisoned state.

As the CO level in the blood increases, the amount of oxygen transported to the body's cells decreases. It is this oxygen deprivation that makes CO so deadly. Sensitive parts of the body like the nervous system, brain, heart and lungs suffer the most from this lack of oxygen. Symptoms of mild CO poisoning include headache, fatigue, dizziness, vision problems (particularly double vision), nausea, and increased pulse and respiration. Unfortunately, these symptoms are often attributed to physical and mental stress, flu, indigestion, or the common cold. At higher levels of COHb saturation, breathing may become difficult followed by loss of consciousness, collapse, convulsions, coma, and even death.

Just how sick someone will get from CO exposure varies greatly from person to person, depending on age, overall health, the concentration of CO (measured in parts per million), and the duration of exposure. High concentrations can cause incapacitation within minutes, but low concentrations can still be extremely dangerous if exposed for a period of hours. As CO continues to be inhaled, the percentage of COHb gets higher and higher, and the victim gets sicker and sicker. The eyes are particularly vulnerable to the effects of CO poisoning, and permanent damage can easily occur.

Carboxyhemoglobin is red in color, just as oxyhemoglobin is. (That's why a pulse oximeter is unable to detect CO poisoning.) CO does not disassociate readily from hemoglobin the way O2 does, venous blood remains red rather than turning the normal bluish color. This fact is useful mostly to coroners and morticians, however, because by the time CO poisoning has progressed far enough to turn you noticeably red, you're at least comatose if not dead.

The accompanying tables give you some idea of how various levels of CO concentration in the air and COHb saturation of the blood affect an average person. As you can see, a CO concentration of one tenth of one percent (1,000 parts per million) is enough to render you unconscious in an hour. OSHA has established the maximum permissible CO level for continuous 8-hour-per-day exposure in the workplace at 35 parts per million.

Table 1 — Effects of various CO concentrations at sea level. (At altitude, the effects of CO poisoning and altitude hypoxia are cumulative.)

CO Concentration (parts per million)	Symptoms
35	No obvious symptoms after 8 hours of exposure.
200	Mild headache after 2 to 3 hours.
400	Headache and nausea after 1 to 2 hours.
800	Headache, nausea and dizziness after 45 minutes; collapse after 2 hours.
1000	Unconsciousness after 1 hour.
1600	Unconsciousness after 30 minutes.

Table 2 — Effects of various COHb saturations.

COHb Saturation (%)	Symptoms
0 - 10	None. (Smoking yields 3% to 10% COHb.)
10 - 20	Tension in forehead, dilation of blood vessels.
20 - 30	Headache and pulsating temples.
30 - 40	Severe headache, weariness, dizziness, vision problems, nausea, vomiting, prostration.
40 - 50	Same as above, plus increased breathing and pulse rates, asphyxiation.
50 - 60	Same as above, plus coma, convulsions, Cheyne-Stokes respiration.
60 - 70	Coma, convulsions, weak respiration and pulse. Death is possible.
70 - 80	Slowing and stopping of breathing. Death within hours.
80 - 90	Death in less than 1 hour.
90 - 100	Death within minutes.