

CARBON MONOXIDE—The Hidden Killer

What is Carbon monoxide?

Carbon monoxide is a gas produced by incomplete burning of organic (carbon based) substances, this occurs when the amount of oxygen to support burning is insufficient. Carbon monoxide, which is odourless and colourless, is a dangerous gas that can and does cause death. Many deaths have occurred as a result of poorly maintained heating appliances.

Carbon monoxide is dispersed by wind and destroyed by photochemical processes in the atmosphere over a period of months.

Certain people may be exposed to carbon monoxide through their work e.g. those working in coal mines or heavy industry.

Carbon monoxide concentrations in outdoor air are highest next to busy urban roads and lowest at remote rural locations. Carbon monoxide concentrations are greatest in the winter (especially on cold, windless days) and lowest in the summer months.

Sources of Carbon monoxide

The majority of carbon monoxide found at ground level in the northern hemisphere is likely to have resulted from human activities:

- burning from motor vehicle engines
- burning from gas cookers, paraffin heaters, bottled gas heaters in poorly ventilated rooms
- badly installed or maintained flued gas, oil or solid fuel heating appliances
- burning of oil, wood etc.
- coal mining and other industrial processes, gas leakage
- cigarette smoking (the major exposure source for tobacco smokers)

Air quality standard

The level recommended by the Expert Panel on Air Quality Standards for carbon monoxide is 10 parts per million (ppm) measured as a running 8-hour average. The running 8 hour average is calculated by taking the recorded carbon monoxide level a number of times over an hour and dividing by the number of readings. These hourly averages are then taken consecutively in groups of eight and the 8 hourly averages calculated for 0-8 hours, 1-9 hours and so on. Smokers, in general, have elevated levels of carbon monoxide in their blood stream and will not be influenced by additional exposure to carbon monoxide levels normally

found in ambient air. In fact, they may be air pollution sources for carbon monoxide.

Health effects of Carbon monoxide

Carbon monoxide is easily absorbed into the body when breathed into the lungs. Uptake depends on the concentration of carbon monoxide in the breathed air and the amount of physical activity a person is undertaking (uptake increases with increasing carbon monoxide concentrations and increasing exertion). Carbon monoxide binds more easily than oxygen to the protein in the blood which normally carries oxygen. After a certain period of time a steady state will be reached where the protein cannot bind any more carbon monoxide without releasing some which is expelled in exhaled air. The effect of carbon monoxide exposure is to reduce the amount of oxygen available to the tissues of an exposed person. Carbon monoxide also interferes with biochemical reactions within the body's cells.

The binding of carbon monoxide to the protein which usually carries oxygen in the blood (carboxyhaemoglobin) provides a convenient method for monitoring exposure using a blood sample. Most people are exposed to varying concentrations throughout the day and a steady state is often not reached. Uptake of carbon monoxide from multiple sources, smoking and traffic, is not additive. Smokers who have a level of carbon monoxide bound to protein in the blood above the steady state value that would be reached by breathing the air in their surroundings are liable to act as "sources", breathing out carbon monoxide rather than absorbing more.

Those most at risk from carbon monoxide include people with a disease which impairs the delivery of oxygen to the heart or brain such as established cardiac and lung disease or anaemia. The unborn child, young infants and the elderly may also be susceptible.

Short term exposures

The first sign of severe poisoning is loss of consciousness and further inhalation leads to death. Among those who recover from accidental or deliberate carbon monoxide poisoning, brain damage of some degree is common.

In healthy people breathing carbon

monoxide may reduce their ability to reach their maximum level of physical activity. However, carbon monoxide levels in the blood stream rising to 6-9% have not produced any significant effect on exercise performance. At carbon monoxide levels of more than 5% healthy volunteers have shown subtle changes in sustained attention and in sustained hand-eye co-ordination performance.

In people with cardiac problems lower levels of carboxyhaemoglobin (2-4%) shorten the amount of exercise which can be done before chest pain occurs and may lead to electrocardiogram changes.

Long term exposures

Of most concern is the effect of long-term exposure to carbon monoxide. This can lead to lethargy, persistent headaches, unconsciousness and death. Making sure that domestic heating appliances e.g. gas boilers, hobs, ovens and fires are regularly serviced, and the use of carbon monoxide detectors may prove life saving, especially for those people who are likely to spend much of their time indoors.

What are the medical effects of carbon monoxide and how do I recognize them?

Carbon monoxide inhibits the blood's ability to carry oxygen to body tissues including vital organs such as the heart and brain. When CO is inhaled, it combines with the oxygen carrying hemoglobin of the blood to form carboxyhemoglobin. Once combined with the hemoglobin, that hemoglobin is no longer available for transporting oxygen. How quickly the carboxyhemoglobin builds up is a factor of the concentration of the gas being inhaled (measured in parts per million or PPM) and the duration of the exposure. Compounding the effects of the exposure is the long half-life of carboxyhemoglobin in the blood. Half-life is a measure of how quickly levels return to normal. The half-life of carboxyhemoglobin is approximately 5 hours. This means that for a given exposure level, it will take about 5 hours for the level of carboxyhemoglobin in the blood to drop to half its current level after the exposure is terminated.

The following table describes the symptoms associated with a given concentration of COHb:

% COHb	Symptoms and Medical Consequences
10%	No symptoms. Heavy smokers can have as much as 9% COHb.
15%	Mild headache.
25%	Nausea and serious headache. Fairly quick recovery after treatment with oxygen and/or fresh air.
30%	Symptoms intensify. Potential for long term effects especially in the case of infants, children, the elderly, victims of heart disease and pregnant women.
45%	Unconsciousness.
50%+	Death.

Since one can't easily measure COHb levels outside of a medical environment, CO toxicity levels are usually expressed in airborne concentration levels (PPM) and duration of exposure. Expressed in this way, symptoms of exposure can be stated as follows:

PPM CO	Time	Symptoms
35	8 Hrs	Maximum exposure allowed by OSHA in the workplace over an eight hour period.
200	2-3 Hrs	Mild headache, fatigue, nausea and dizziness.
400	1-2 Hrs	Serious headache- other symptoms intensify. Life threatening after 3 hours.
800	45 min	Dizziness, nausea and convulsions. unconscious within 2 hours. Death within 2-3 hrs.
1600	20 min	Headache, dizziness and nausea. Death within 1 hr.
3200	5-10 min	Headache, dizziness and nausea. Death within 1 hr.
6400	1-2 min	Headache, dizziness and nausea. Death within 5-30 min.
12,800	1-3 min	Death



The Council of Gas Detection and Environmental Monitoring

www.cogdem.org.uk

Helpline: 0800 1694457