Recognition of Chronic Carbon Monoxide Poisoning

Lynda Knobeloch, PhD, and Russhawn Jackson, PhD

ABSTRACT
Chronic exposure to low levels of carbon monoxide can cause vague symptoms that are easily mistaken for other common illnesses. During the past 5 years, three families have contacted the Wisconsin Division of Public Health to report illnesses that may have been caused by chronic exposure to carbon monoxide. Members of these families were diagnosed with a variety of conditions including chronic fatigue syndrome, depression, and influenza. Carbon monoxide exposure was not suspected as a cause of these illnesses until heating contractors discovered that gas appliances in these families’ homes were not properly vented. These cases serve as reminders that chronic symptoms of headache, fatigue, dizziness, nausea, and mental confusion can be more serious health problems.

INTRODUCTION
Each year in the United States, more than 200 deaths and approximately 5000 injuries are caused by residential exposure to carbon monoxide.1 While acute carbon monoxide poisoning is readily diagnosed, illnesses that can be caused by long-term exposure to lower concentrations of carbon monoxide are much more difficult to recognize.2,3 Common symptoms of exposure to low levels of carbon monoxide include headache, fatigue, dizziness, shortness of breath, nausea, and mental confusion. If the exposure is ongoing, these symptoms can become chronic and may lead to more serious health problems.

During the past 5 years, the Wisconsin Division of Public Health has been contacted by three individuals who described chronic health problems that were apparently caused by long-term exposure to carbon monoxide. Their case histories are remarkably similar.

CASE REPORTS
Case I: In October 1995, a Bayfield County man contacted the Wisconsin Division of Public Health to ask about the long-term health effects of carbon monoxide exposure. He reported that a heating contractor had recently discovered that a low section in the exhaust system for his gas furnace was filled with water from condensation. The furnace had been installed during the fall of 1994 and the resident expressed concern that the obstruction might have allowed carbon monoxide and other combustion byproducts to accumulate in his home.

During the winter of 1994–1995, his wife and 14-year-old son experienced chronic symptoms of headache, nausea, mental confusion and fatigue. His wife fainted on several occasions while bathing in a heated bathroom, but recovered spontaneously.

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after being moved to an unheated bedroom. Her condition, which was initially diagnosed as chronic fatigue syndrome, gradually improved after the ventilation problem was corrected. A 2-year old grandson, who lived with the couple that winter, was diagnosed with a developmental speech disorder called aphasia during the summer of 1995. The man who reported this case recalled having headaches, but felt that he was affected less than other family members because he worked outside the home several hours a day.

**Case 2:** In November 1998, a 56-year-old Milwaukee County resident contacted the Division of Public Health to request information about exposure to carbon monoxide. When asked about her exposure she explained that a contractor, who was installing a new water heater in her home, found that her gas furnace and water heater were not properly vented to the interior of the chimney. Instead, the exhaust from these appliances was vented to a dead space between the walls of her home, which was constructed in 1955. This woman, who had lived alone in the home since 1970, recalled having episodes of dizziness, nausea and fatigue that began in the mid-1970’s. Her condition deteriorated over the next 2 decades and by 1994, she was too debilitated to continue her work as a medical technologist. She retired that year at the age of 52.

Between 1979 and 1998 this woman was evaluated by several different physicians. She was diagnosed with a variety of medical conditions including a suspected middle ear infection, depression, migraine headaches, and chronic fatigue syndrome. One month after the ventilation problem in her home was corrected, she reported that her headaches were less severe, however she continued to experience symptoms of dizziness and nausea.

**Case 3:** In April 1999, a Dane County resident reported that a newly-installed gas fireplace had malfunctioned over the winter heating season, releasing soot and combustion byproducts into the apartment she shared with her daughter. This problem was identified after she noticed soot stains behind holiday decorations that had been displayed on the fireplace mantle. In response to her concerns, the fireplace installer inspected the unit. After operating the fireplace for 15 minutes, he measured a carbon monoxide level of 112 parts per million (ppm) in the apartment. Additional investigations were conducted by the local fire department and municipal building inspector. Both of these inspectors noted soot stains throughout the apartment and recommended that the fireplace be replaced.

Between September and January, the fireplace was in use approximately 12 hours a day. The adult resident experienced headaches, dizziness, and extreme exhaustion, which she attributed to a viral infection. Her 2.5-year-old daughter was lethargic and irritable, and vomited on several occasions. During the period of her exposure, this child had eight clinic visits and was examined by three different pediatricians. Her symptoms were repeatedly attributed to “the flu.”

**DISCUSSION**

Carbon monoxide is an extremely hazardous gas that has no warning taste or odor. It is produced by incomplete combustion of organic fuels such as wood, gasoline, natural gas, coal, charcoal and fuel oil. Carbon monoxide binds to hemoglobin to form carboxyhemoglobin. Because carboxyhemoglobin is unable to transport oxygen, the condition causes a variety of physiological effects that are secondary to hypoxia. The tissues most affected are those with the highest oxygen demand, such as the brain, heart, and skeletal muscle. In acute poisonings, the severity of symptoms is related to the level of carboxyhemoglobin in the blood (see Table 1).

Pregnant women and people who have pulmonary or cardiovascular diseases are more susceptible than healthy individuals. Children may also be at higher risk, however, few studies have been done to evaluate this. The fetus is extremely susceptible to the effects of CO and the gas readily crosses the placenta. Prenatal exposures can cause congenital malformations, low birth weight, and permanent brain dam-

<table>
<thead>
<tr>
<th>Carboxyhemoglobin level (% HgB)</th>
<th>Signs and Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5%</td>
<td>None</td>
</tr>
<tr>
<td>5-10%</td>
<td>May exacerbate angina in patients with heart disease</td>
</tr>
<tr>
<td>10-20%</td>
<td>Mild headache, breathlessness on exertion</td>
</tr>
<tr>
<td>20-30%</td>
<td>Throbbing headache, irritability, mental changes, fatigue</td>
</tr>
<tr>
<td>30-40%</td>
<td>Severe headache, weakness, nausea, dizziness, visual problems, confusion</td>
</tr>
<tr>
<td>40-50%</td>
<td>Increased confusion, hallucinations, severe ataxia, rapid breathing</td>
</tr>
<tr>
<td>50-60%</td>
<td>Syncope or coma with convulsions, tachycardia with weak pulse</td>
</tr>
<tr>
<td>60-70%</td>
<td>Deep coma, incontinence of urine and feces</td>
</tr>
<tr>
<td>70-80%</td>
<td>Profound coma, depressed respiration, absent reflexes</td>
</tr>
<tr>
<td>&gt;80%</td>
<td>Rapid death from respiratory arrest</td>
</tr>
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</table>
Air quality standards have not been established for
than 9 ppm in residential areas (8-hour average).14

standards require that CO levels in outdoor air be less
8 hours a day, 5 days a week. Federal air quality
intended to protect healthy workers who are exposed
25 ppm for carbon monoxide.13 This standard is
Hygienists has developed a workplace standard of
or the use of an air conditioner.

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resident's exposure may have continued during the
involved the water heater, as well as the furnace, this
addition, since the ventilation problem in this home
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considerably depending on the severity of the expo-
exposure to CO is not well known and may vary
affected. Whether CO exposure was
occurred over a period of more than 20 years.
During that time, the occupant of this home experi-
ence progressive symptoms of headache, nausea and weakness. Whether CO exposure was
the sole cause of her illness is uncertain. Local public
health officials were skeptical that her illness could
have been caused by CO because her condition did
not improve during the summer months. However, the
length of time needed to recover from long-term exposure to CO is not well known and may vary
considerably depending on the severity of the expo-
and the individual's general health status. In
addition, since the ventilation problem in this home
involved the water heater, as well as the furnace, this
resident's exposure may have continued during the
summer months — especially if the windows and
doors were kept closed because of security concerns
or the use of an air conditioner.

The American Conference of Government Industrial
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25 ppm for carbon monoxide.13 This standard is
intended to protect healthy workers who are exposed
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standards require that CO levels in outdoor air be less
than 9 ppm in residential areas (8-hour average).14

Air quality standards have not been established for
homes. However, Underwriters Laboratory requires
residential CO detectors to sound an 85 decibel
alarm within 90 minutes if the CO concentration is at
100 ppm, within 35 minutes at 200 ppm, and 15
minutes at 400 ppm.

The cases described in this article serve as remind-
ers of the potential health threat posed by carbon
monoxide, even when it is present at sub-lethal levels.
Residential sources of this gas include automotive
exhaust from attached garages and improperly-
vented stoves, fireplaces, furnaces, clothes dryers and
water heaters. Virtually all homes are at risk. Although
there is no legal requirement that homes or apart-
ments be equipped with CO detectors, health care
providers should encourage patients to buy at least
one detector and install it in the sleeping area of their
home.

Health care professionals should also be aware of
the symptoms of CO exposure and consider CO in
their differential diagnosis of patients who present
with vague flu-like symptoms. Triage should include
questions about whether the patient’s symptoms seem
to improve or worsen in different environments,
whether other members of their household — including
pets — have been ill, and about potential sources of
CO in the home. The diagnosis is confirmed by a
blood test for carboxyhemoglobin. Pulse oximetry is
not useful since oxyhemoglobin and carboxyhemoglo-
bin are absorbed at the same wavelength.15 Non-
exposed individuals typically have carboxyhemoglo-
bin levels below 5%, however, the level can be as
high as 10% in an active smoker. A blood level
greater than 5% in a symptomatic patient may
indicate chronic CO toxicity and requires further
evaluation.

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