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Carbon Monoxide (CO) Poisoning

With the tragic passing of Jeffrey Rodliff, 23, both the University of Vermont Community and the state as a whole has become instantly familiar with carbon monoxide poisoning. The purpose of this report is to discuss possible governmental action that can be taken to prevent a tragedy such as this from occurring again.

What is Carbon Monoxide?

Carbon monoxide (CO) is an odorless, invisible gas created by the incomplete combustion of fossil fuels.¹

Physical Effects of CO

Carbon monoxide forms an easier and stronger bond with hemoglobin in the blood than does oxygen. The resulting compound, carboxyhemoglobin (COHb), is carried to the cells and tissues of the body's organs. As levels of CO in a person's bloodstream and the body increase, the body begins to become deprived of oxygen. The bonding strength of COHb makes it difficult to eradicate from the body.² While lower concentrations of CO are remedied with fresh air, high levels of CO exposure (over 20 percent COHB) often require treatment with a hyperbaric oxygen chamber.³

Carbon Monoxide Poisoning in the Home

According to data released in 1999 by the United States Consumer Safety Commission unintentional non-fire related carbon monoxide poisoning in the home was responsible for 213 fatalities per year from 1992-1996,⁴ making it the leading cause of poison death in the United

¹ AV Web. "Carbon Monoxide Detectors." <http://www.avweb.com/news/aeromed/186016-1.html> viewed 02/15/2005

² AV Web. "Carbon Monoxide Detectors." <http://www.avweb.com/news/aeromed/186016-1.html> viewed 02/15/2005

³ NHS Scotland: Hyperbaric Medicine Unit "Carbon Monoxide." http://www.hyperchamber.com/co_poisoning/ viewed 02/22/05.

⁴ State Farm Life Insurance Company. "Carbon Monoxide Alarms." <http://www.statefarm.com/consumer/vhouse/articles/carbon.htm> viewed 02/10/05.

States (See Figures 1.1 and 1.2).⁵ This statistic increases by more than 60 percent when CO poisoning as a result of exposure to automobile exhaust is included.⁶

The Center for Disease Control estimates that total non-fire related carbon monoxide deaths numbered approximately 480 per year from 2001-2002.⁷

A study of Washington, Idaho, and Montana hospitals found that carbon monoxide poisoning accounted for 52.9 out of every 100,000 emergency room visits in 1994.⁸ While this rate is higher than the national average, the intra-state disparity is primarily caused by climate.⁹ As such, assuming a similar rate for Vermont is reasonable. In 2003, Vermont had 403 emergency room visits per 1,000 residents.¹⁰ Using the Pacific Northwest data, Vermont can expect approximately 210 instances of treatment for CO exposure in a given year.

A report released by Fire Safety Director John Wood in December of 2004 cites 490 total carbon monoxide incidents reported by fire departments and five total carbon monoxide fatalities in Vermont from 2001-2003.¹¹

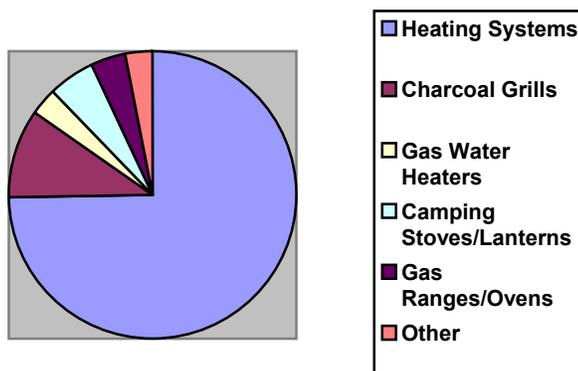


Figure 1.1
Causes of Non-Fire-Related Carbon Monoxide Poisoning in the Home 1992-1996¹²

⁵ Minnesota Poison Control System. "Winter Hazards." <http://www.mnpoison.org/index.asp?pageID=149> viewed 02/08/05.

⁶ National Center for Environment Health. "Carbon Monoxide Poisoning Fact Sheet." <http://www.cdc.gov/nceh/airpollution/carbonmonoxide/cofaq.htm> viewed 02/08/05.

⁷ Center for Disease Control. "Morbidity and Mortality Weekly Report, January 21, 2005." <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5402a2.htm> viewed 02/20/05.

⁸ Hamson, N.B. *Journal of Emergency Medicine* "Emergency Departments for Carbon Monoxide Poisoning in the Pacific Northwest-Another Great Imitator." Sept 1998 v16 i5 p695(4).

⁹ Center for Disease Control. "Morbidity and Mortality Weekly Report, January 21, 2005." <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5402a2.htm> viewed 02/20/05.

¹⁰ State Health Facts Online. "Vermont: Hospital Emergency Room Visits Per 1,000 Population. 2003." http://www.statehealthfacts.kff.org/cgi-bin/healthfacts.cgi?action=profile&category=Providers+%26+Service+Use&subcategory=Hospitals&topic=Emergency+Room+Visits&link_category=&link_subcategory=&link_topic=&welcome=0&area=Vermont viewed 02/15/05.

¹¹ Wood, John "Officials Warn of Carbon Monoxide Dangers in Vermont." 12/14/04. <http://www.state.vt.us/labind/Press/carbonmon04.htm> viewed 02/20/05.

¹² State Farm Life Insurance Company. "Carbon Monoxide Alarms." <http://www.statefarm.com/consumer/vhouse/articles/carbon.htm> viewed 02/10/05.

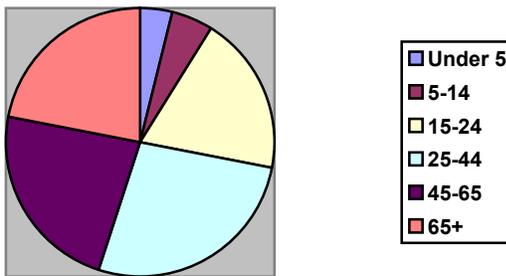


Figure 1.2
*Victims of Carbon Monoxide Poisoning in the Home by Age, 1992-1996*¹³

According to a CBS news report, three out of four homes in the United States lack a single carbon monoxide detector.¹⁴ Typical levels of CO in homes without gas stoves vary from 0.5 ppm to 5.0 ppm.¹⁵ U.S. National Ambient Outdoor Air Quality Standards specify a maximum level of 9 ppm for an 8 hour period, and 35 ppm for a 1 hour period.¹⁶ In the workplace, The National Institute for Occupational Safety and Health (NIOSH) permissible exposure limit for CO is 50 ppm for an 8-hour time-weighted average concentration.¹⁷ Sources of carbon monoxide in the home include kerosene and gas space heaters, leaking chimneys and furnaces, back-drafting from furnaces, gas water heaters, wood stoves, fireplaces, gas stoves, generators, gasoline powered equipment, automobile exhaust from attached garages, and tobacco smoke.¹⁸ Exposure to levels of CO greater than 70 ppm can produce symptoms that resemble a feverless flu.¹⁹ Exposure to levels of CO greater than 150 ppm can result in death.²⁰

¹³ State Farm Life Insurance Company. "Carbon Monoxide Alarms."

<http://www.statefarm.com/consumer/vhouse/articles/carbon.htm> viewed 02/10/05.

¹⁴ Senay, Emil. CBS News "Carbon Monoxide, The Killer At Home." October 2002.

<http://www.cbsnews.com/stories/2002/10/02/earlyshow/contributors/emilysenay/main524167.shtml> viewed 02/08/05.

¹⁵ United States Environmental Protection Agency. "Sources of Indoor Air Pollution- Carbon Monoxide."

<http://www.epa.gov/iaq/co.html> viewed 02/08/05.

¹⁶ United States Environmental Protection Agency. "Sources of Indoor Air Pollution- Carbon Monoxide."

<http://www.epa.gov/iaq/co.html> viewed 02/08/05.

¹⁷ OSHA "Occupational Safety and Health Guideline For Carbon Monoxide.

<http://www.osha.gov/SLTC/healthguidelines/carbonmonoxide/recognition.html> viewed 02/18/05.

¹⁸ United States Environmental Protection Agency. "Sources of Indoor Air Pollution- Carbon Monoxide."

<http://www.epa.gov/iaq/co.html> viewed 02/08/05.

¹⁹ Consumer Product Safety Commission. "Carbon Monoxide Questions and Answers."

<http://www.cpsc.gov/cpsc/pub/pubs/466.html> viewed 02/08/05.

²⁰ Consumer Product Safety Commission. "Carbon Monoxide Questions and Answers."

<http://www.cpsc.gov/cpsc/pub/pubs/466.html> viewed 02/08/05.

Carbon Monoxide Detectors

Carbon Monoxide detectors are differentiated by their power source. The three major detector types are battery operated, plug-in, and hardwired. All of these categories have detectors capable of monitoring both CO and smoke levels.²¹

Battery operated CO detectors are not affected by electrical blackouts and brownouts, or by a fire that cuts off electricity to the house, and they can be placed anywhere. Standard batteries must be replaced annually and lithium batteries can last up to six years.²²

Plug-in CO detectors require an available wall outlet. While this restricts placement options, plug-in detectors do not require battery replacement.

Hard-wired CO detectors are detectors that are continuously connected to an electrical power supply, and to every other detector throughout the structure. While this is the most complex and expensive detector system, it requires the least maintenance after installation and provides the most comprehensive coverage.²³

Carbon Monoxide Detector Standards

When CO detectors were initially made available to consumers, there was wide disparity in the accuracy of detection. To remedy this problem, the Consumer Product Safety Commission (CPSC), in conjunction with Underwriters Laboratories (UL), developed uniform standards for CO detectors and alarms.²⁴ The CPSC recommends detectors that bear the UL seal and which were manufactured after January 1, 2000.²⁵

Cost

The average cost of CO detectors can range from \$7 to \$60 dollars.²⁶ The detector recommended by the independent product-testing group Consumer Research as most accurate and durable, is

²¹Smokesign.com "Carbon Monoxide Detectors." <http://www.smokesign.com/sarsam/codetectors.html> viewed 02/22/2005

²² Christophersen, E. Ph.D. Allina Hospitals & Clinics. "Smoke, Heat, and Carbon Monoxide Detectors." http://www.medformation.com/ac/crspa.nsf/file/crs-pa-pa_smoke.detectors viewed 02/10/05.

²³ Smarhome.com. "Cabling for A Security System." <http://www.smarhome.com/solution40.html> viewed 02/10/05.

²⁴ Consumer Product Safety Commission. "Carbon Monoxide Questions and Answers CPSC Document #466" <http://www.cpsc.gov/cpscpub/pubs/466.html> viewed 02/10/05.

²⁵ Consumer Product Safety Commission. "Carbon Monoxide Questions and Answers CPSC Document #466" <http://www.cpsc.gov/cpscpub/pubs/466.html> viewed 02/10/05.

²⁶Christophersen, E. Ph.D. Allina Hospitals & Clinics. "Smoke, Heat, and Carbon Monoxide Detectors 2004." http://www.medformation.com/ac/crspa.nsf/file/crs-pa-pa_smoke.detectors viewed 02/10/05.

the Kidde Nighthawk 900 that costs 50 dollars.²⁷ CO detectors may also be bought in bulk (of 100 etc.), decreasing the cost of each detector as low as \$20.²⁸

Benefits CO Detectors

A functioning carbon monoxide detector can save lives. On February 10, 2005, firefighters in Alston, Massachusetts evacuated more than 200 students from their apartment complex. Four people were hospitalized, and firefighters found that an improperly ventilated oil burner had created levels of CO in the building greater than 200 parts per million.²⁹

A study published in the Journal of Emergency Medicine, which examined carbon monoxide calls responded to by paramedics found that instances without a CO detector registered concentrations of the gas more than five times greater than homes equipped with a detector.³⁰ Detecting CO before concentrations reach critical levels prevents not only death, but other injuries associated with acute exposure.

In Chicago, a city with a detector mandate, 0.4 percent of persons exposed to carbon monoxide in the home died as a result of the exposure. The same Journal of Emergency Medicine study found that Los Angeles, a city without a detector mandate, had a 15% casualty rate for persons exposed.³¹ In other words, detector legislation appears to reduce the death rate from carbon monoxide exposure, primarily by registering and alerting residents of elevated levels of CO before the concentration becomes fatal.

Economic Impact of Requiring CO Detectors

Requiring CO detectors in every home in Vermont would come at a substantial total cost. According to the 2000 Census, there are 240,634 households in the state.³² Assuming an average cost of \$25 per detector, and that not more than 25 percent of households currently have a CO detector, the residents of Vermont would be paying a minimum of more than four million dollars to equip their domiciles.

Carbon Monoxide Legislation: Municipal and State

The city of Chicago requires carbon monoxide detectors in single-family homes, multiple family homes, and apartments. Single-family homes heated by forced air furnace or boilers that

²⁷ Consumer Search. "Carbon Monoxide Detector Review." http://www.consumersearch.com/www/house_and_home/carbon_monoxide_detectors/fullstory.html viewed 2/17/05.

²⁸ Smokesign.com <http://www.smokesign.com/codetectors.html> viewed 02/10/05.

²⁹ *Boston Globe*. "Students Taken to the Hospital After Carbon Monoxide Leak." http://www.boston.com/news/local/massachusetts/articles/2005/02/10/students_taken_to_hospital_after_carbon_monoxide_leak/ viewed 02/10/05.

³⁰ The American Journal of Emergency Medicine. "Carbon Monoxide. The Silent Killer with the Audible Solution." Vol. 14, Issue 5 September 1996 pg. 484-486.

³¹ Petersen, Andrea. *Real Estate Journal* "This Life-Saving Device Appears in More Homes." <http://www.realestatejournal.com/housegarden/toolsgadgets/20021029-petersen.html> viewed 02/15/05.

³² The US Census Bureau's Center For Rural Studies. "Demographic Profiles for Vermont." <http://crs.uvm.edu/census/2000dps/04050.pdf> viewed 02/10/05.

operate on fossil fuel must have a CO detector within forty feet of each bedroom. Multiple family homes and apartment buildings that utilize fossil fuel powered steam or water heat must have a detector in the room that contains the central heating unit, as well as a detector in each apartment within forty feet of the bedroom.³³

In New York City, Mayor Michael Bloomberg signed Local Law 7 in May of 2004. This law requires that one CO detecting device be installed within 15 feet of each bedroom in single homes, group homes, hotels, motels, apartment houses, dormitories, hospitals, nursing homes, and other housing facilities. While owners of the buildings are responsible for the initial installation of the CO detectors, upkeep is the responsibility of the tenant or occupant, and the owner has the right to request a \$25 reimbursement for the cost of the device. The Fire Department, the Department of Buildings, the Department of Health and Mental Hygiene, and the Department of Housing Preservation and Development are tasked with ensuring compliance to the law.³⁴

Alaska House Bill 351, sponsored by Max Gruenber (D-Anchorage), added carbon monoxide detectors to the state statute that already required smoke detectors be installed by homeowners and landlords to be maintained by the occupants of the housing.³⁵ As of January 1, 2005 CO detectors are required in single-family homes, duplexes, apartment buildings, garages, and near any carbon-fueled appliances or non-electric space heaters. It is recommended but not required that individuals who live, or spend substantial periods of time, in RV's, cabins, or boats use carbon monoxide detectors.³⁶

In 2002, Rhode Island amended Public Law 177 to require all buildings constructed or converted for residential use after the passage of the law that are equipped with gas utilities to have installed a minimum of one carbon monoxide detector (certified by UL or some other nationally recognized testing laboratory).³⁷

Recommendations for Carbon Monoxide Poisoning Prevention

Numerous governmental and medical organizations recommend the installation of carbon monoxide detectors for protection against CO poisoning. The Center for Disease Control recommends families install CO detectors in their homes to prevent accidental death or injury.³⁸

³³Chicago Fire Department. "Carbon Monoxide Detectors." <http://www.cityofchicago.org/Fire/Prevention/CODetectors.html> viewed 02/08/05.

³⁴ Mayors Office Press Release. "Mayor Michael R. Bloomberg Warns New Yorkers of the Dangers of Carbon Monoxide." <http://www.nyc.gov/html/hpd/html/for-researchers/mayors-release279-04-pr.html> viewed 02/08/05.

³⁵ Alaska's House & Senate Legislators' E-News. "Gruenber's Lifesaving CO Detector Passes Senate." http://www.akdemocrats.org/enews/enews_050804.htm viewed 02/10/05.

³⁶ Alaska Department of Public Safety. "Carbon Monoxide Alarms" <http://www.dps.state.ak.us/fire/pdf/coinformation.pdf> viewed 02/10/05.

³⁷ Rhode Island Public Law 177. "An Act Relating to Health and Safety." <http://www.rilin.state.ri.us/PublicLaws/law01/law01177.htm> viewed 02/20/05.

³⁸ Center of Disease Control. "Carbon Monoxide Poisoning Health Tips" http://www.cdc.gov/nceh/airpollution/carbonmonoxide/health_tips.htm viewed 02/10/05.

The American Lung Association recommends the installation of carbon monoxide detectors to protect against potential lung damage and death.³⁹ The United States Environmental Protection Agency recommends both the installation of CO detectors and the annual inspection of fuel burning appliances.⁴⁰ The Consumer Product Safety Commission recommends that individuals install CO detectors that fulfill the requirements of Underwriters Laboratories, specifically UL Standard 2034, in the hallways near bedrooms.⁴¹

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³⁹ American Lung Association. "Carbon Monoxide."
<http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=35370> viewed 02/10/05.

⁴⁰ United States Environmental Protection Agency. "Protect Your Family and Yourself from Carbon Monoxide Poisoning." <http://www.epa.gov/iaq/pubs/coftsht.html> viewed 02/10/05.

⁴¹ Consumer Product Safety Commission "Carbon Monoxide Detectors Can Save Lives: CPSC Document #5010." <http://www.cpsc.gov/CPSCPUB/PUBS/5010.html> viewed 02/10/05.

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