

Carbon Monoxide Poisoning (CO)

PROTOCOL CHECKLIST

- Enter available information into Merlin upon receipt of initial report
- Review information on the poisoning and its epidemiology (see page 2), case definition (see page 4), and laboratory testing (see page 8)
- Contact provider (see page 8)
- Interview patient(s)
 - Review poisoning facts (see page 2)
 - Complete case report form
 - Exposure information
 - Symptoms
 - Ask about exposure to relevant risk factors (see page 3)
 - Generator
 - Automobile/ RV
 - Boat
 - Kerosene/ gas space heater
 - Power tools (include mower)
 - Fuel burning appliances (fixed stove/ boiler/furnace)
 - Portable fuel burning grill/ stove
 - Other: fire, charcoal grills or briquettes for cooking and heating indoors, etc.
 - Intentional poisoning (suicide or homicide)
 - Provide education on reducing future exposures (see page 9)
 - Install a CO alarm
 - Vent appliances appropriately
 - Do not leave vehicle running in a closed garage
 - Address case-patient's questions or concerns
 - If exposure is thought to be intentional and criminal, report to local law enforcement immediately.
- Follow-up on special situations, including possible intentional contamination (see page 10)
- Enter additional data obtained from interview into Merlin (see page 9)

Carbon Monoxide Poisoning (CO)

1. DISEASE REPORTING**A. Purpose of reporting and surveillance**

1. To determine if there is a persistent source of exposure of public health concern.
2. To prevent further/continued exposure.
3. To inform/ educate those exposed or at risk of being exposed how to reduce their possible exposure to CO.
4. Additionally, CO poisoning data may be used to:
 - Recognize patterns and evaluate trends in environmental conditions, population exposure and rates of disease.
 - Measure impacts of public health interventions.
 - Identify populations most affected or most vulnerable.
 - Identify opportunities for research and/or public health interventions to reduce exposures to potential environmental health hazards and prevent disease.

B. Legal reporting requirements

Laboratories, physicians, and emergency responders are required to report CO poisonings to the local county health department (CHD) within one working day of identification/diagnosis.

C. County health department investigation responsibilities

1. Begin investigation on the same day as notification.
2. Immediately notify Chemical Disease Surveillance Program (CDSP) when a cluster (two or more related cases) of CO poisoning is suspected. DOH epidemiologists and toxicologists are available to assist CHDs with investigations as needed.
3. Enter into the Merlin reporting system. Attach case report form (CRF) and other related documents (e.g., Medical Examiners report) in Merlin.
4. Direct case-patient to phone numbers below for more information.

1-800-222-1222 (Florida Poison Control Center, available 24/7)

2. THE DISEASE AND ITS EPIDEMIOLOGY**A: Etiologic agent**

Carbon monoxide (CO) is an odorless, colorless, and poisonous gas that can cause sudden illness and death if present in sufficient concentration in the ambient air. When power outages occur during emergencies such as hurricanes or winter storms, the use of alternative sources of fuel or electricity for heating, cooling, or cooking can cause CO to build up in a home, garage, or camper and poison the people and animals inside. Unintentional CO poisoning can occur outdoors during activities like boating or camping from sources such as boat exhaust, gasoline-powered generators, and non-electric heaters. Generators, grills, camp stoves, or other gasoline, propane, natural gas, or charcoal-burning devices should never be used inside a home, basement, garage, or camper - or even outside near an open window or window air conditioner.

B: Description of illness

The clinical presentation of acute carbon monoxide (CO) poisoning varies depending on the duration and magnitude of exposure and between individuals with the same degree of

exposure and/or the same venous carboxyhemoglobin (COHb) level. The most common signs and symptoms include headache, nausea, lethargy (or fatigue), weakness, abdominal discomfort/pain, confusion, and dizziness. Other signs and symptoms may include visual disturbances including blurred vision, numbness and tingling, ataxia, irritability, agitation, chest pain, dyspnea (shortness of breath), palpitations, seizures, and loss of consciousness.

C. Reservoirs:

Not applicable

D. Modes of transmission

Transmission is through inhalation of higher than normal levels of CO in the air/ environment.

Common types of CO exposure are:

- Generator
- Automobile/RV
- Boat
- Kerosene/gas space heater
- Power tools (include mower)
- Fuel burning appliances (fixed stove/boiler/furnace)
- Portable fuel burning grill/stove
- Other: fire, charcoal grills, charcoal briquettes for both cooking and heating indoors, etc.

E. Incubation period

Not applicable

F. Period of communicability

Not transmissible person to person.

G. Treatment:

Individuals should seek medical care immediately if CO exposure is suspected. Typical treatments may involve:

- Administering 100% oxygen until the patient is symptom-free, usually about 4-5 hours. Serial neurologic exams should be performed to assess progress, and to detect the signs of developing cerebral edema.
- Hyperbaric oxygen therapy (HBO) therapy when the patient has a COHb level of more than 25-30%, there is evidence of cardiac involvement, severe acidosis, transient or prolonged unconsciousness, neurological impairment, abnormal neuropsychiatric testing, or the patient is ≥ 36 years in age. HBO is also administered at lower COHb (<25%) levels if suggested by clinical condition and/history of exposure.
- Hyperbaric oxygen is the treatment of choice for pregnant women, even if they are less severely poisoned. Hyperbaric oxygen is safe to administer and international consensus favors it as part of a more aggressive role in treating pregnant women.

H. Prophylaxis

No prophylactic treatment indicated.

I. CO poisoning in Florida

CO poisoning first became reportable in November 2008 and was included in the 2009 Annual Morbidity Report for the first time. CO poisoning is the leading cause of unintentional poisonings in the United States. The true incidence of CO poisoning is unknown in Florida, as

many low-level exposures go undetected.¹ In 2009, the majority of CO poisoning cases were unintentional (81%). Only 16% were recorded as intentional.

3. CASE DEFINITIONS

A. Clinical description

The clinical presentation of acute CO poisoning varies depending on the duration and magnitude of exposure and between individuals with the same degree of exposure and/or the same venous carboxyhemoglobin (COHb) level. The most common signs and symptoms include headache, nausea, lethargy (or fatigue), weakness, abdominal discomfort/pain, confusion, and dizziness. Other signs and symptoms may include visual disturbances including blurred vision, numbness and tingling, ataxia, irritability, agitation, chest pain, dyspnea (shortness of breath), palpitations, seizures, and loss of consciousness.

B. Laboratory criteria for diagnosis

Biologic: elevated carboxyhemoglobin (COHb) concentration found in blood specimen determined by laboratory tests. Elevated levels of carboxyhemoglobin should be interpreted in light of endogenous production, patient smoking status, and exposures to second hand smoke.

OR

Environmental: detection of CO from environmental monitoring data as provided by first responders (Fire Department, Hazmat, etc.), environmental consultants, or other sources if deemed reliable.

C. Case classification

Confirmed: A clinically compatible case in which laboratory tests or pulse CO-oximetry have confirmed elevated COHb level ($\geq 9\%$).

OR

A case with signs and symptoms consistent with CO poisoning (in the absence of clinical laboratory data), and supplementary evidence in the form of environmental monitoring data suggesting exposure from a specific poisoning source.

OR

A case with a reported blood specimen (in the absence of clinical and environmental laboratory data) with COHb level that is equal to or greater than a volume fraction of 0.12 (12%).

Probable: A clinically compatible case with no laboratory and/or environmental monitoring evidence of exposure with the same environmental exposure as that of a confirmed case

OR

A clinically compatible case, with no laboratory and/or environmental monitoring evidence of exposure with smoke inhalation secondary to conflagration (explosive fire).

OR

A case with a reported blood specimen of COHb level that is equal or greater than a volume fraction of 0.09 (9%) and less than a volume fraction of 0.12 (12%), ($9\% \leq \text{COHb} < 12\%$) in the absence of compatible symptoms or environmental monitoring data.

Suspected:

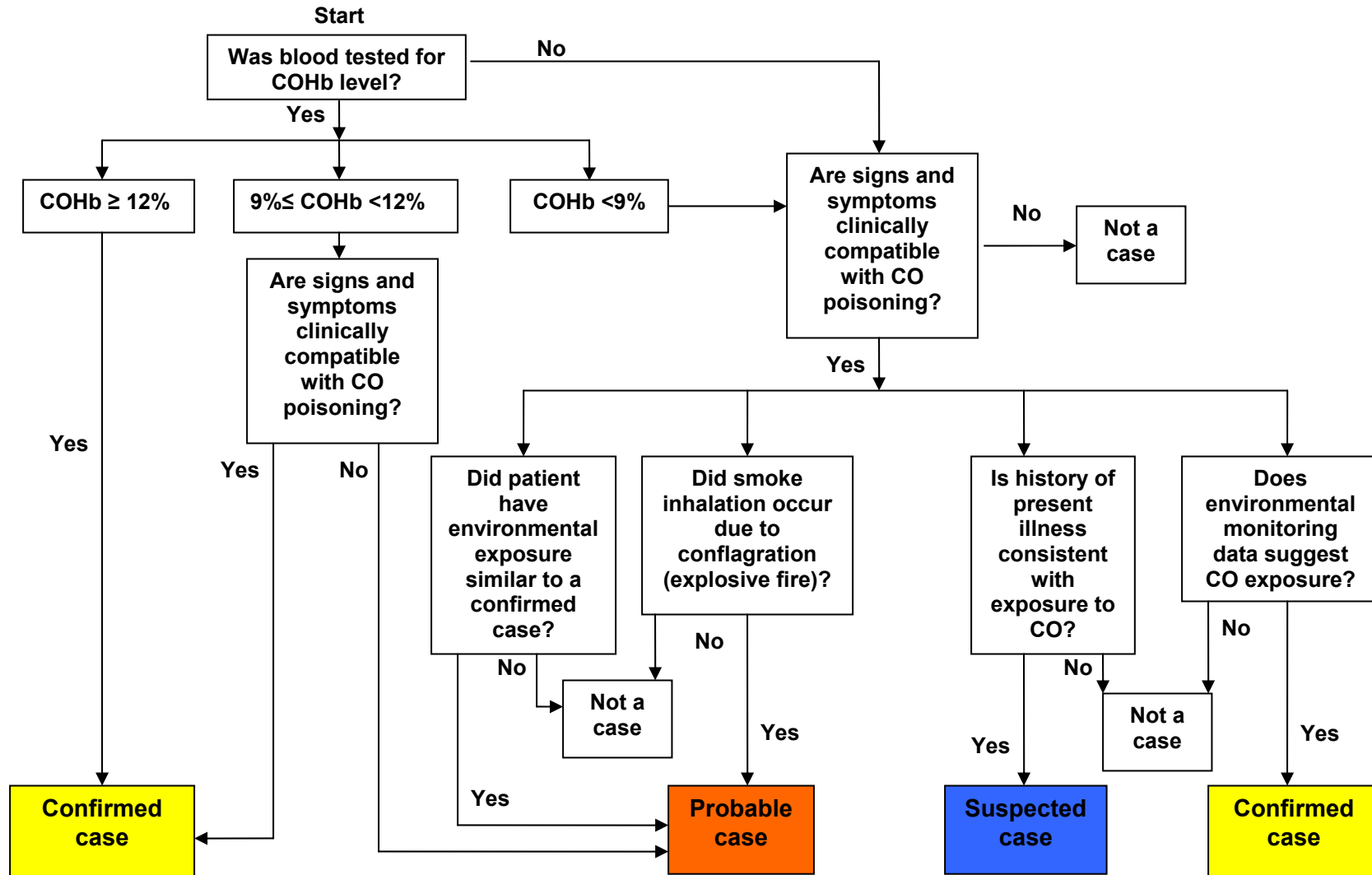
A clinically compatible case that is not laboratory confirmed but has a history of present illness that is consistent with exposure to CO.

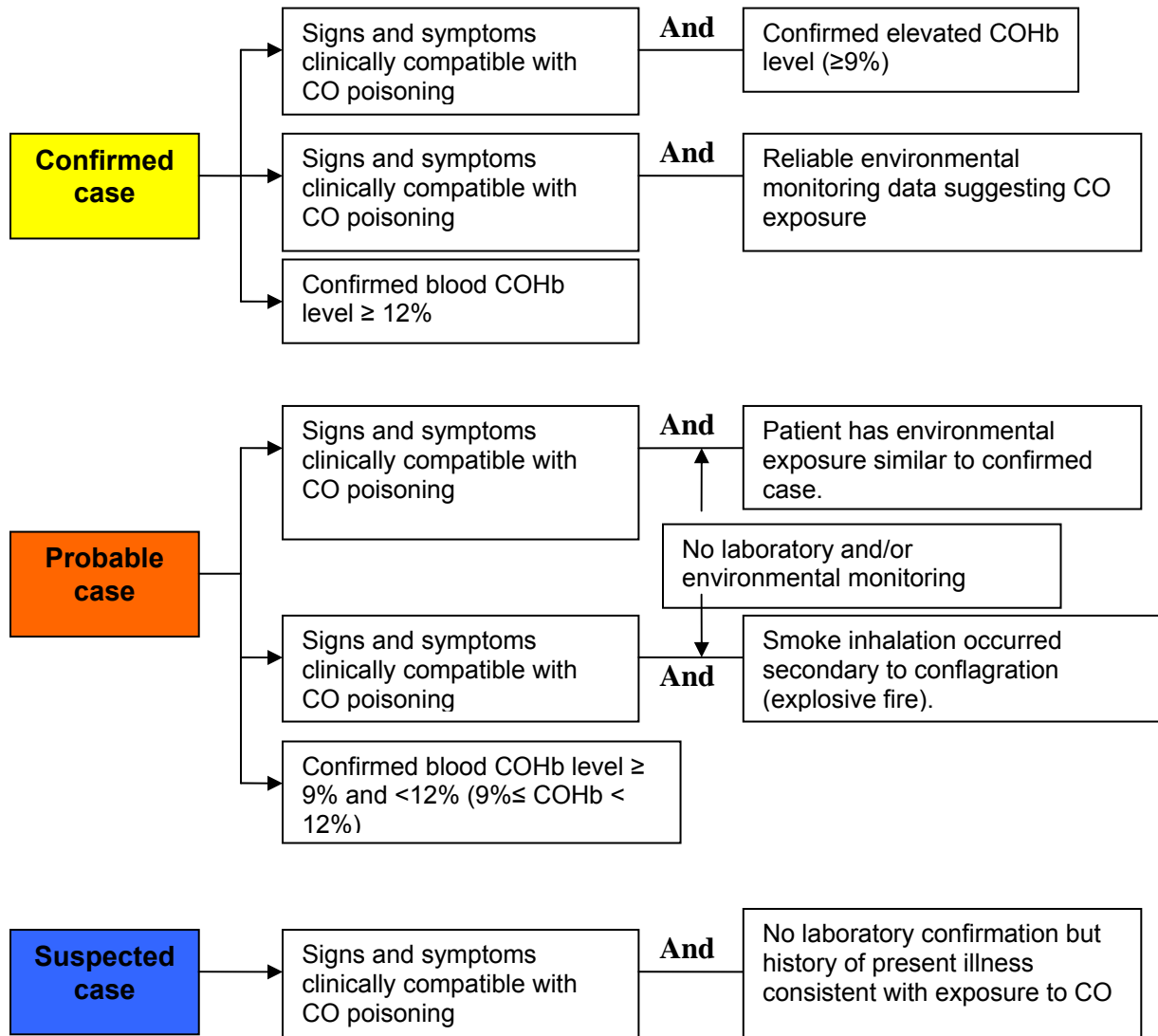
For example a CO poisoning death due to extended intentional or unintentional exposure to exhaust from an automobile, generator or fireplace.

D. Comment

Reliable CO environmental monitoring data: the acceptance of these data is at the discretion of the public health investigator/official. The quality of environmental monitoring data is dependant on the capabilities and limitations of the monitoring equipment and the equipment users. False positives among environmental monitoring data are possible (e.g., some CO sensor technologies are known to be cross-sensitive when exposed to other chemicals such as hydrogen sulfide). Please contact the Department of Health, Bureau of Community Environmental Health, Radon and Indoor Air Program Office at (850) 245-4277 or (800) 543-8279 for assistance with the interpretation of CO environmental monitoring data.

Carbon Monoxide (CO) poisoning Flow Charts:





4. LABORATORY TESTING

A. Criteria for diagnosis

The laboratory tests to confirm CO poisoning involves measuring the patient's COHb level. The most common technology available in hospital laboratories for analyzing blood is the multiple wavelength spectrophotometer, also known as a CO-oximeter. Venous or arterial blood may be used for testing. It is important to know how much time has elapsed since the patient has left the toxic environment, because the elapsed time from exposure to measurement does affect the resulting COHb level measured. If the patient has been breathing normal room air for several hours, COHb testing may be less useful.

B. Interpretation of results

Test results:

Elevated COHb level: For laboratory criteria for case classification, COHb level $\geq 9\%$ is considered elevated.

Normal COHb level: For laboratory criteria for case classification, COHb level $< 9\%$ is considered to be normal.

5. CASE INVESTIGATION

A. Contact the physician or hospital

1. Confirm that a CO poisoning has occurred.
2. Gather as much relevant data as possible to complete the CRF and Merlin data fields.
3. Ask what information has been given to the patient, including whether the patient knows about the diagnosis.
4. Notify the physicians that you will be contacting the case as DOH follows up on all reported CO Poisonings. It may also be appropriate at this point to determine if the physician has any concerns about the health department contacting the case.

B. Interview the case

1. Contact the case or proxy to complete an interview as soon as possible after being reported to optimize recall.
 - a. Make at least three phone call attempts to reach the case.
 - b. Calls should be made at different times of the day, with at least one attempt in the evening.
 - c. Determine if others are known to be exposed to the same possible exposure.
 - d. Provide basic instruction to cases and potentially exposed contacts about CO poisoning and how to prevent it.
2. Determine intent
 - a. Intentional CO poisoning: Involves suicidal or homicidal use of CO.
 - b. Unintentional CO Poisoning: CO is a colorless, odorless, tasteless, non-irritating gas; many people do not realize they have been exposed until they experience symptoms of CO poisoning. Consider as unintentional if patient is unaware of potential exposure to CO.

C. Environmental evaluation

For the purposes of CO case definition, it is suggested that epidemiologists consider environmental monitoring data, associated with the suspect case report, at 80 parts per million (ppm) or higher as a level that is likely to produce symptoms and signs of acute CO poisoning. This environmental monitoring value was calculated based on the Coburn-Forster-Kane equation, a model using CO uptake in humans, using 12% CoHb levels in blood in the equation.

Average levels in homes without gas stoves vary from 0.5 to 5 ppm. Levels near properly adjusted gas stoves are often 5 to 15 ppm and those near poorly adjusted stoves may be 30 ppm or higher.⁵ Public health, occupational health, and emergency levels of concern vary from 9 ppm⁵ (US Environmental Protection Agency's National Ambient Air Quality Standards for concentration over eight hours average) to 1,200 ppm (National Institute for Occupational Safety and Health's immediately dangerous to life and health concentration) depending on the specific target population (the public or workers) and the duration of exposure (moments to hours).⁶

Reliable sources for environmental monitoring data include hazardous materials teams, fire department responders, and environmental consultants using field calibrated CO measurement instruments. Unfortunately, as with many types of environmental monitoring technologies, there is a possibility of false positive readings in the presence of other interfering gasses such as hydrogen sulfide. Since the reliability of some residential CO alarms have not been determined and cannot be field calibrated, a report of an auditory alert or readout from a residential CO alarm should not be considered as reliable environmental monitoring data for the purposes of this case definition. Should there be a question regarding the interpretation of reported CO environmental measurements associated with a suspect case, please contact your regional or county health department's indoor air quality specialist (if there is one) or the State Radon and Indoor Air Program at (800) 543-8279. Additional information can be found at: <http://www.doh.state.fl.us/environment/community/indoor-air/index.html>.

D. Merlin data entry

Create a case in Merlin under disease code **CARBON MONOXIDE POISONING-98600**. Enter the data collected into Merlin, being sure to include all required fields on the Basic Data screen, and attach all relevant labs. Please attach **ALL** labs received via electronic laboratory reporting (ELR) to the case. ***Signs and symptoms cannot be entered into Merlin.**

6. CONTROLLING FURTHER SPREAD

A. Patient/ household education on prevention recommendations

- Install a CO alarm in your home if you have combustion appliances or an attached garage.
- Be sure all appliances are properly installed and used according to the manufacturer's instructions.
- Have fireplace, combustion heating, and ventilation systems, including chimneys, flues, and vents, professionally inspected every year.
- Do not burn charcoal inside a house, garage, vehicle, tent or fireplace.
- Do not use un-vented combustion heaters in enclosed spaces, especially sleeping areas.
- Never leave an automobile running in a closed garage or in a garage attached to the house - even with the garage door open.
- While driving, keep the rear window or tailgate of a vehicle closed, as carbon monoxide from the exhaust can be pulled inside.
- If you suspect you are experiencing any symptoms of CO poisoning, open doors and windows, turn off gas appliances and go outside. In cases of severe CO poisoning, call 911 emergency services or call the Florida Poison Information Center at 1-800-222-1222.

DOH posted an educational video on CO poisoning prevention courtesy of the California Air Resources Board at: <http://www.youtube.com/watch?v=t5rlyN6LuoU>.

B. Isolation of cases

Not applicable

C. Management of contacts

Not applicable

D. Laboratory testing during outbreaks

Same as during non-outbreaks

E. Food or water is implicated as the source of an outbreak

Not applicable

7. MANAGING SENSITIVE SITUATIONS

If thought to be an intentional poisoning, call the FDLE immediately.

8. IMPORTANT LINKS

1. Chemical Disease Surveillance Program:
http://www.doh.state.fl.us/Environment/medicine/Chemical_Surveillance/
2. Carbon Monoxide Poisoning:
http://www.doh.state.fl.us/Environment/medicine/Carbon_Monoxide_Poisoning.html
3. Florida Morbidity Statistics Report 2009:
http://www.doh.state.fl.us/disease_ctrl/epi/Morbidity_Report/amr_2009.pdf
4. CDC Carbon Monoxide Poisoning:
<http://www.cdc.gov/co/>
5. The 2011 Florida Statutes:
<http://www.leg.state.fl.us/Statutes/index.cfm?Mode=View%20Statutes&Submenu=1&Tab=statutes&CFID=236588325&CFTOKEN=64948788>
Sections 553.885 & 509.211, F.S.: require that every building for which a building permit is issued for new construction on or after July 1, 2008 and have an enclosed space or room that contains a boiler shall have an approved operational carbon monoxide alarm installed.

9. REFERENCES

- ¹Thom S, Keim L. Carbon monoxide poisoning: A review. Epidemiology, pathophysiology, clinical findings, and treatment options including hyperbaric therapy. *Clin Toxicol* 1989; 27:141-156.
- ²CDC. Unintentional Non-Fire-Related Carbon Monoxide Exposures - United States, 2001-2003. *MMWR*, 2005; 54(02):36-39. Available at <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5402a2.htm>
- ³Harduar-Morano L, Watkin S., "Review of Unintentional Non-Fire Related Carbon Monoxide Poisoning: Morbidity and Mortality in Florida (1999-2007)". *Public Health Reports* 2011;126:240-250.

⁴CDC, Emergency preparedness and Response, Clinical Guidance for Carbon Monoxide (CO) Poisoning After a Disaster, Retrieved from http://emergency.cdc.gov/disasters/co_guidance.asp on December 28, 2011.

⁵EPA, An Introduction to Indoor Air Quality, Carbon Monoxide (CO), Retrieved from <http://www.epa.gov/iaq/co.html> on December 28, 2011..

⁶CDC, National institute for Occupational Safety and Health (NIOSH), NIOSH Pocket Guide to Chemical Hazards, Retrieved from <http://www.cdc.gov/niosh/npg/npgd0105.html> on December 28, 2011

UPDATES

See CO poisoning surveillance web page for most recent information and additional details-
http://www.myfloridaeh.com/medicine/Carbon_Monoxide_Poisoning.html