

To: Rep. Rob Ecklund, Chair
Minnesota House of Representatives
Committee on Labor, Industry, Veterans and Military Affairs Finance & Policy

From: Leslie L. Lienemann
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612-597-2024

Re: Committee Hearing on HF2284
Tuesday, March 23, 2021 3:00 p.m.

I am an advocate who will be testifying in favor of HF2284, a bill to require hotels to install carbon monoxide detectors in each guest room used for sleeping. I will testify about carbon monoxide poisoning injuries my son and I suffered while sleeping in a hotel and our continued health issues. I would like to provide the committee with background materials relative to understanding the scope of the existing threat, cause of the threat, status of the law and number of past injuries.

Problem:

Carbon Monoxide is a deadly gas that causes immediate injuries ranging from headaches, dizziness and vomiting to unconsciousness and death, with potential long-term injuries including headache, fatigue, dizziness, and varying degrees of brain injury. See, CDC Clinical Guidance for Carbon Monoxide Poisoning, attached hereto. Carbon Monoxide is a particular risk during sleeping hours, as people can become incapacitated while sleeping. For this reason, hotel facilities are frequent sites of carbon monoxide injuries.

No CO detector requirement: No states require installation of carbon monoxide detectors in each individual hotel sleeping room. A few states require CO detectors in hallways or in areas near gas burning appliances. These provisions are inadequate to prevent injury, as demonstrated by the frequency of carbon monoxide injuries detailed in the attached materials. In addition, carbon monoxide gas can be introduced by motor vehicles running outside the hotel or in attached parking structures, and can travel across hallways and in ceiling, floor, and other spaces, making CO detectors localized to maintenance areas inadequate to alert sleeping guests.

No reporting requirement: Hotels are not required to report carbon monoxide leaks or injuries. Fire departments may voluntarily report leaks to the National Fire Incident Reporting System (NFIRS), <https://nfirs.fema.gov>, but are not required to do so, and are not required to report injuries. As an example, my injuries were not reported to the NFIRS by the Warren, Michigan police and fire departments, despite each agency responding to the scene and generating reports documenting the CO leak.

Data on carbon monoxide poisoning is often not made public. See, Jenkins Foundation Data, submitted herewith, for a compilation of data generated by that foundation based upon publicly available information.

According to data compiled by REM Consultants and published on their website www.remrisk.com (see below), there were at least 12 carbon monoxide leaks at Minnesota hotels in the year 2018 alone, with no data being identified relating to injuries.

Who is at risk:

Every individual sleeping in a hotel room without a carbon monoxide detector, every employee of a hotel without carbon monoxide detector, emergency personnel.

My Personal Story:

In July of 2019, I traveled to Michigan with my then-eighteen-year-old son so that he could compete in a NAHL junior hockey tryout camp. We checked in on a Wednesday afternoon, and that night woke up with extreme headaches. We remained in the room. The next day, my son struggled in his hockey tryout and I continued to feel ill. The second night, we again woke up with extreme headaches. There was no carbon monoxide detector in the room. We stayed. On the third night, we again awoke with extreme headaches. This time, we felt dizzy and nauseated. I began to vomit, and we decided to go to the emergency room. In the emergency room, the doctor struggled to find the source of our illness, until he decided to take blood samples, nearly an hour after we had left the hotel. The blood sample taken an hour after we left the hotel room showed my carboxyhemoglobin (COHgb) level to be nearly 27%. My son's level was 22%. According to the CDC, a COHgb level of above 2% for a non-smoker is considered "elevated." Carboxyhemoglobin levels of greater than 20%-30% cause shortness of breath, headache, fatigue, disturbed judgment, dizziness and other symptoms. See, information attached hereto printed from acutearetesting.org. Higher levels cause unconsciousness and death.

The emergency room doctor notified 911 to evacuate the hotel. The fire department measured our room to have CO level of 260ppm. For context, safe CO exposure limits have been identified by various agencies as being no more than 8ppm (parts per million) to 50ppm. (see Jenkins Foundation data attached). Levels above 150 ppm become life threatening within 3 hours. See, GASLAB.COM, Carbon Monoxide Levels, attached.

We were given oxygen treatment at the emergency room, and we traveled back to Minnesota. In the weeks that followed, we suffered sleeplessness, fatigue, "brain fog," headaches, dizziness and other physical and emotional symptoms, some of which persist nearly two years later.

After we suffered carbon monoxide poisoning, I learned that three years prior to our stay, two guests of this same hotel were found unconscious due to carbon monoxide poisoning. Despite this prior incident, the hotel did not install carbon monoxide detectors in the guest rooms.

Solution: Installing inexpensive carbon monoxide detectors in individual guest rooms will save lives and prevent severe injuries like the ones my son and I suffered.

It has been suggested that requiring hotels to install carbon monoxide detectors in Minnesota would cost the hotels, in aggregate, \$3.6M. I do not know the source of that estimate. However, according to the State of Minnesota Explore Minnesota web site, www.explore@state.mn.us, there are 968 hotels in Minnesota, averaging approximately 100 rooms per hotel. A CO detector can be purchased at retail cost at any local hardware store for under \$30, and they last for 5-7 years. At an average cost per hotel of \$3,000, that cost spread over the life of the detector would be about \$0.16 per day per room.

Who is Protected by HF2284

Hotel guests: This bill would prevent death or injury to hotel guests and employees.

Had there been a CO detector installed the room in which my son and I stayed, I would have known on the first night that there was poison gas in our room. Because there was no alarm, I was unaware that my son and I were sleeping in a room filled with poisoned gas—for three nights. Had there been an alarm, I could have informed the emergency room personnel there was a CO detector alarming, which would have alerted them to begin oxygen treatments much sooner.

Hotel employees: Hotel employees will also be protected by this bill. Every hotel is a workplace. Because CO is colorless and odorless, without appropriate CO detection, hotel employees can sustain acute or chronic exposure to CO without understanding the cause of the symptoms.

Hotel businesses: Carbon monoxide injuries are extremely detrimental to the businesses in which they occur. Injuries to hotel guests are bad for business, both in terms of liability claims and in terms of public relations. Hotel employees can suffer carbon monoxide poisoning, as well, causing claims for worker's compensation benefits.

Attached materials:

Dale & Shirley Jenkins Foundation Data Compilation of hotel CO deaths and injuries since 1969, www.thejenkinsfoundation.com

Hotel Carbon Monoxide Incident Data, REM Risk Consultants, <https://remrisk.com/resources/carbon-monoxide-hotels/> 02/08/2021, including data reported to NFIRS

Center for Disease Control and Prevention, Clinical Guidance for Carbon Monoxide (CO) Poisoning

GASLAB.com, Carbon Monoxide Levels Chart

Causes and Clinical Significance of Increased Carboxyhemoglobin, Printed from acutecaretesting.org

U.S. Hotel/Motel Carbon Monoxide Incidents - 1967 to date (1-4-2021)

State	City	Date of incident	Victims	Name of facility	Chain/member hotel	# of deaths	# of injured	# of child victims (18 and under)	Source of CO	Location of source and/or problem	Incident details/notes
OH	Boston Heights	11/18/67	Betty Ann Bishop, 50 & sister Mary "Budd" Bishop, 56 (both deceased); Bruce, 22 (deceased) & wife Joan Plagman, 21 (injured)	Best Western Yankee Clipper Inn	Y	3	100		pool heater	basement laundry room	11/18/1967 was a Saturday and over 500 people were at hotel for three different weekend events; a couple began to feel dizzy about 6:30pm and went to their room thinking they were catching the flu or ate something bad, at 11:30pm the man called the front desk for help because his wife had "fainted"; hotel sent a doctor who was onsite at a medical conference to their room - he was suspicious it was something they might have inhaled and called for an ambulance; at the same time the couple arrived to the emergency room, another couple arrived with the same symptoms from the hotel; CO was immediately suspected by an ER doctor and "every ambulance possible" was sent to hotel, along with "two hundred police officers, deputies and firefighters"; hotel sent seven stories, 21 rooms to a floor, and most were occupied; room by room evacuation, guests were found "sprawled on floors, stretched across beds, moaning incoherently"; evacuation took two hours to complete; 3 people were discovered deceased, more than 100 people were injured, 60 hospitalized including six police officers who assisted with evacuation; carbon monoxide was traced to a swimming pool heater in a basement laundry room. "It's vent had been installed too closely to a fresh-air intake, which spread fumes through ducts to the upstairs"
IL	Glen Ellyn	12/10/67	Susan, 21 (deceased), & husband Anthony Grieshaber, 19 (injured), Mrs. Peter Decker, 45 (injured) & daughter Christine Decker, 17 (injured)	Holiday Inn	Y	1	3	1 injured	heating unit		couple was staying on fourth floor and were found by clerk - she was deceased, he was unconscious and not expected to survive (unable to find information to confirm); woman and her daughter were staying in room on second floor were ill and taken to hospital - they had checked in around 11pm, woman was dizzy and nauseated when awakened by her daughter who was vomiting around 5am; motel was four-stories with 121 rooms and had been open for approximately one week; CO entered 14 rooms of hotel via "one or more loose-fitting joints in the metal tube chimney"
OK	Lawton	12/28/67	Linda F. Klinekole, 20 (deceased)	Hacienda Motel		1			heater	room	Victim found deceased in room
OH	Ironton	1/3/68	Walter Kelley, 43 (deceased) & wife Lucille Kelley, 41 (injured)			1	1		heater	office	Victims were owners of the motel, husband found deceased in office and wife unconscious in adjoining bedroom
CO	Aspen	12/22/68	Jacquelyn Lazan, 24 (deceased), Joy Levy, 24 (injured)			1	1		heater	room	victims discovered by manager when they failed to check out; snow delayed injured victim's transport by helicopter to a treatment facility in Denver
OK	Kellyville	12/31/68	Richard Kuffel, 39 & wife, Darlene, 31, & their 5 children (all injured)				7	5 injured	heater		victims were a couple and their 5 children; father was awakened by one of the children who was vomiting and crying - staggered to door and called for help; motel manager called ambulance; motel was newly opened
CA	Norden	12/31/68	Germaine Cliff, 18 (deceased)			1		1 deceased	heater	room	victims were permanent residents of the motel, discovered deceased in their room by a friend; cause determined to be a coffee pot that "boiled over, extinguishing the flame and allowing the gas to escape"
FL	Holly Hill	1/20/69	William T. Byram, 54 & wife Martha, 35 (both deceased)	White Palms Motel		2			gas range	room	victims discovered in their room by a friend six days after they were last seen alive
AZ	Tucson	1/22/69	James R. Johnston, 78 & wife Ethel, 77 (both deceased)	Gammill Motel		2			wall heater	room	
UT	Soldier Summit	2/11/69	Jimmy Inskip, 15 (deceased)			1		1 deceased			
MN	Rochester	2/16/69	Barbara Briggs, 21 (deceased)	Rochester Motel		1			gas heater	room	victim discovered by employer when she failed to show up at work two days in a row; she had been living at the motel
TX	Victoria	2/22/69	Sonia Medrano, 42 (deceased) & Ruben Cantu, 35 (injured)	Ranch Motel		1	1		heater	room	victims found by hotel manager at 3:00pm when they failed to check out at noon; woman found lying across bed, death approximated to be five hours earlier, and man was found unconscious on floor
TX	El Paso	3/16/69	Jeri, 32 (deceased) & husband Carl Cappel, 40 (injured)	Del Camino Motor Inn		1	1		furnace	room	victims discovered in their room when they failed meet traveling companions for breakfast, wife dead and husband unconscious; "a gas floor furnace in the room was found to have faulty pipes"; owner/manager subsequently charged with negligent homicide
LA	Opelousas	12/24/69	Mr. & Mrs. Everette Witt (both injured)				2				Fire Dept called to motel at 4:30am for "couple overcome with gas fumes"
AR	Hot Springs	1/12/70	Ernest J. Sander, 72 (deceased) & wife Emma Sander (injured)	Central Motel		1	1				victims checked into motel on 1/8, both ill and weak on 1/10 and doctor was called to hotel - initially diagnosed with possible pneumonia; on 1/12 owners and maid found husband unconscious and wife semi-conscious, transported to hospital where husband died 4 days later; source of CO undetermined - 2 gas heaters and a gas stove in room
CA	Palm Springs	4/17/70	Cyril Joseph Carey, 47 (deceased)	Sunshine Court Motel		1			heater		
FL	Delray Beach	11/26/70	Lovella Hagabook, 45 (deceased) & husband (injured - no name or age listed)	Fred's Motel		1	1		charcoal heater	room	

CA	Hollywood	12/20/70	Joseph Felice, 21 (injured), Phillip Martone, 21 (injured)	Chesterfield Hotel			2	heater	room	hotel employee found both victims unconscious in their room when they failed to check out; Felice was unconscious for six weeks and Martone was unconscious for five days until receiving appropriate treatment in for CO poisoning, both originally diagnosed as suffering from a drug overdose until they were transferred to a different medical facility where they were diagnosed with CO poisoning
NM	Ruidoso	12/20/70	John Gridham, 18 (deceased), Rod Krebs, 17 (injured), Leland Parks, 17 (injured), Andrew Gubb, 17 (injured), Keith Ellis, 18 (injured), Tim Ridpath, 18 (injured)	West Winds Motel		1	5	heating stove	room	victim was among 5 other teenagers who were staying at hotel for skiing holiday; they all began experiencing nausea and headaches during first night's stay (Monday), completely slept thru next day (Tuesday), Wednesday 3 of them went out to get fresh air and something to eat and when they returned were unable to rouse victim, unable to locate manager so drove hospital to notify ambulance and police
TX	Brownsville	12/31/70	Felix Valadez, 23 (deceased) & Frances Olga Perez, 20 (deceased)	Jayhawk Motel		2		heater	room	victims discovered deceased in room by motel owner - they had checked in at 12:30am and at 6pm owner went to room to inquire if they would be spending a second night
OK	Hammon	1/14/71	Woodrow "Buck" Snow, 55 (deceased) & wife Alene Snow, 50 (deceased)			2		wall heater	room	checked into hotel two days before being found deceased in room, along with their dog, by motel owners; woman's body found in bed, man on floor
IN	East Chicago	1/20/71	Ida Mae Wait, 11 (deceased) & mother Gloria Jean Cottrell, 33 (injured); George Stinnet (deceased), Gene Allen, 50 (deceased), Eli Wilkins, 30 (deceased)	Stevens Hotel		4	9	furnace	basement	police called to hotel by hotel maintenance worker at 3:15am, surviving guests discovered "in various stages of unconsciousness"; police smashed windows to let in fresh air; two-foot section of "rotted" furnace flue pipe separated from chimney was discovered on basement floor; per subsequent investigation and coroner's inquest, after hotel manager was taken to hospital for what was initially thought to be a heart attack around 9:30pm; then a second employee became ill with some symptoms a few hours later, the owner checked on the furnace - he then called furnace repairman at 2am to report flue pipe had fallen off and was instructed to shut off furnace and open basement windows; police testified furnace was running when they arrived and one basement window was open; hotel had been listed for sale two weeks prior; boiler had never been inspected according to Indianapolis city records
CA	Pacifica	1/22/71	Constance Joy Saliccia, 39 (deceased), Lawrence Owen Witthey, 38 (deceased)	Rockaway Beach Motel		2		heater	room	victims discovered deceased in room by maid; woman's body found on bed, man on floor; 84 y/o man (hotel owner's father) had been discovered deceased in the room 9 days prior - had recently suffered a heart attack and autopsy determined he died of a collapsed lung, however cause of death was to be reviewed in light of deaths of the two subsequent victims
IN	Portage	1/27/71	Charles F. Sproul, 35 (deceased), and Patty Lee Young, 31 (deceased)	Gary Motel		2	2			victims discovered deceased in room by police when motel manager could not rouse them, cause attributed to a "faulty gas pipe"
CO	Colorado Springs	3/21/71	Mark A. Taylor, 17 (injured), Michael R. Todd, 17 (injured)	El Rancho Motel			2			victims were discovered unconscious in their room by a friend
NY	Watertown	4/18/71	Viki Jane Reed, 7 (deceased) & sister Tina Reed, 5 (injured); Mrs. Robert Barker (injured - first name and age not listed) & children Terry L. Barker, 13 (deceased), Tammy Barker, 8 (injured)	Hillside Motel		2	3			police were called after a neighbor boy found adult victim lying on the floor; adult victim and her husband listed as owners of motel and were caring for a friend's children who were the additional victims in the room; investigators determined "fumes escaped from a vent pipe that had broken apart"
FL	Pensacola	11/24/71	Ruth Strouza, 53 (deceased), Ervin Barker, 53 (deceased)	Floridian Motel		2		heater	room	victims discovered deceased in room by motel employee
SD	Ipswich	1/25/72	Judith Huber, 23 (deceased) & Bernie Jahnig, 25 (deceased)	Ipswich Motel		2		heater		victims discovered deceased in room by motel owner; CO "may have been caused by ice clogging the motel chimney, preventing venting of carbon monoxide fumes from heating unit"
WY	Jackson	3/29/72	William Palmer, 18 (deceased), Richard Kroiss, 18 (deceased), Dennis O'Connell, 16 (injured)	Sagebrush Motel		2	1	heater	room	victims discovered by motel owner after checking on room when they returned from a two day trip; two days - two were deceased on beds and third was lying semi-conscious on floor; according to fire marshal in charge of investigation, "the exhaust from the gas space heater did not terminate on the exterior of the building...fumes from the heater vented into the attic above the room" "as submitted in the building plan, the whole motel unit was to have used hot water heat. At some point, however, gas space heaters were installed in the three upper rooms when it was determined that hot water would not heat the rooms sufficiently"; several weeks earlier a 21-year-old man was found unconscious in adjacent room but was not reported
TX	Odessa	12/8/72	Randall Earl Hoover, 34 (deceased)	Sunset Motel		1		heater	room	victim found by hotel maid when she went to clean room; open gas heater was located near the bed
NV	Reno	2/6/73		Riverside Hotel			20	boiler		guests ill; casino dealers started collapsing around 10pm - fire dept called at 11:15pm and evacuated hotel; policeman found unconscious on 2nd floor while helping w/evacuation; investigators discovered "leak in boiler room, filtering unnoticed into the casino and parts of the hotel"
AZ	Flagstaff	2/13/73	Clarence C. Bowen, 22 (deceased), David S. Buchanan, 21 (deceased)	Skyline Motel		2		wall heater	room	victims discovered by maid when she went to clean the room; one victim found on a bed, the other on the floor
IL	Springfield	5/30/73		St. Nicholas Hotel			37	furnace	basement	"a fan in the hotel boiler room ceased functioning" allowing carbon monoxide to seep into banquet room which was being used for a conference; people began collapsing, originally suspecting they were suffering from food poisoning; among those injured were three policemen who were helping to evacuate the banquet room

KY	Corbin	5/31/73	Bertrand Devaux 22 (deceased), Richard Porch, 31 (injured), William Yule, 61 (injured) & wife, 51 (injured name not listed), John Cozine, 50 (injured), Julian Hexter, 50 (injured), Gret Witters, 25 (injured)	Howard Johnson	Y	1	6	pool heater	other ambulances were called for other guests and at 5:45am police were called to hotel to investigate - deceased victim found in room 201 while police were evacuating hotel; CO level measured at 270 ppm in room, high levels found in other second floor rooms; "gas originated from pump room where the count was 1000ppm. From here, it filtered into the ventilating system and into the rooms"; State Board of Health report stated possible source to be an improperly vented heater used to heat the swimming pool; a guest staying in room 201 the night before was ill and taken by ambulance to the hospital but treated and released after 30 minutes - returned to the room and passed out again, had planned to stay a second night but decided to go home
AR	Hampton	12/8/73	Ione Schadev, 51 (deceased) & husband Clarence M. Schadev, 65 (injured)	Word's Motel		1	1	heater	victims discovered by hotel owner when they failed to check out
IL	Chicago	12/10/73	Anthony Johnson, 60, Edward Schwartz, 70, Lee Hoagland, 52, S. Davidson, 50 (all deceased)	Hartman Hotel		4	10	water heater	victims found in rooms on the second and third floors; gas furnace and water heater vented into common chimney which had become blocked and caused fumes to fill building
FL	Tampa	12/24/73	Yvonne Ragsdale, 16 (deceased), John D. Tyler, 25 (deceased), Robert D. Kiedhaus, 24 (deceased)	E and L Motel		3	1	heater or stove	victims discovered deceased in room by manager, investigators estimated they had been dead for 24-48 hours
CA	Trinidad	2/22/74	Jeffrey Allen Camahan, 18 (deceased)	Decker's Fireside Lodge		1	1	heater	victim discovered deceased in room by a friend and the owner of the motel, time of death determined to be 5-6 days prior; investigation showed cause to be an improperly installed and improperly calibrated propane gas heater; prior occupants of room experienced nausea, headaches and fainting and had complained to the owner of the lodge; following a coroner's inquest the victims parents were quoted "We just wanted the public to know about this. A student comes up here and has a right to turn the heater on in his room and have it be safe. We just wanted people to know what was going on so Jeff won't have died in vain."
IA	Okoboji	5/22/74	Walker A. Johnston, 78 (deceased) & wife Neva Johnston, 76 (deceased)	Lakeshore Motel		2			victims discovered deceased in room by hotel owner who had not seen them since the prior day; room contained a gas range, gas space heater and a gas refrigerator (confirmed source of CO not listed); the couple's dog was found alive in the room but "very sick"
NY	South Cairo	11/22/74	William Cassell, 20, Robert Gagbelle, 27, Martha Nally, 18 (all deceased)	Greystone Motel		3	1	space heater	victims discovered deceased by motel owner when they failed to check out; police investigation discovered malfunction of space heater provided by motel
NM	Cloudcroft	1/4/75	Pauline Frazier, 26 (deceased) & husband Donald Frazier (injured) & son Rickie Frazier, 2 (injured)	Spruce Cabins		1	2	heater	victims checked into motel late in the afternoon and at approximately 8pm the husband went to motel office to ask if there was a doctor because wife was ill - hotel staff advised him to take her to the emergency room; at 11:20am the following morning the manager went to room because they had not checked out, husband collapsed after answering door; wife deceased on bed; two other couples had reported being ill in the room prior to family checking in
TX	Tulio	2/1/75	Ethel J. Johnson, 34 (deceased) & William Wigfall, 34 (deceased)	Hillcrest Motel		2		heater	victims discovered deceased in room around 9:45am by maid after friends knocked on door and got no response
AR	Calico Rock	2/8/75	Sharon Hansard Tyrer, 21 (deceased), Annetta Reddman, 26 (injured)	White River Motel		1	1	heater	victims discovered by motel manager after housekeepers got no answer to knock at door
IL	Decatur	11/13/75	Debra Kidd, 22 (deceased)	Decatur Hotel		1	1		death originally investigated by police as an overdose, investigation re-opened when autopsy report did not agree with police investigation; subsequent investigation found a "faulty flue" - hotel had repaired the flue 3 days after the woman's death
CA	Santa Maria	12/27/75	Chad Kelsey, 2 (deceased) & mother Cheryl Kelsey, 19 (injured)	Western Motel		1	1	heater	child discovered deceased in hotel room, mother unconscious
MO	Joplin	6/8/76		Ramada Inn	Y		9	pool heater	on 6/8 ambulances called for ill victims in rooms 125 and 225; a responding police officer remembered that the two rooms had been involved in prior ambulance calls and notified the Health Dept who immediately closed the rooms and began investigation; discovered the rooms were directly above the pool heater; prior incidents of ill guests being taken to the hospital on 4/30, 5/9, 5/18, 5/19, 6/4 - all occurred between 4 and 6am; hotel manager said he was aware of several of the incidents but did not relate incidents to a common cause, some told him they thought they had food poisoning; "The investigation showed that natural gas was not burning properly in the pool heater and was giving off carbon monoxide"
TX	Del Rio	11/14/76	Willie Lee Isaac, 22 (deceased)	Palm Courts Motel		1			victim checked into room around 8:30pm Friday, discovered deceased on floor of room by motel owner at 5:45pm Sunday; investigating officers reported "the victim's room was filled with soot halfway up the walls"
GA	Jeffersonville	11/16/76	Henry Lee Navarre, 46 (deceased), James Cecil Foster, 50 (deceased)			2		heating system	victims were discovered by coworker who went to wake them for work

TX	Harrington	1/31/77	Michael Wysonig, 40 (injured)	Little Creek Hotel			1	1	heater	room	victim found by hotel maid 17 hours after checking in; transported to hospital in comatose state where doctors diagnosed CO poisoning
MI	Espanola	3/29/77	Peter Begay, 59 (deceased)	Livingston Hotel			1		space heater	room	victim found dead in room the morning after checking in; death caused by CO leaking from disconnected exhaust vent attached to gas space heater in room
FL	Miami Beach	5/24/77		Montmartre Hotel			43				guests began feeling ill on Sunday but attributed symptoms to illness; most were at hotel attending a Red Cross convention - two days later began to be investigated as an environmental cause; guests were all staying in north wing of hotel; conflicting reports in news stories as to source of CO
NV	Las Vegas	7/15/77	Frank Gulla, 55 (deceased)	Landmark Hotel-Casino			1	138	auxiliary power generator	basement	auxiliary power generator turned on which produced CO and carried it throughout 31 stories of hotel via air conditioning vents; auxiliary generator came on when "a leaky pipe poured two feet of water into a sub-basement, drowning out an electrical control panel and knocking out the regular power supply"; originally investigated as a refrigerant gas leak until treating physicians diagnosed CO poisoning in victims; many of the hotel guests were attending a Disabled American Veterans convention; estimated 1000 guests evacuated; injured victims included guests, hotel workers and fireman; evacuation slow due to only one elevator operating; 31-story hotel
KY	Lebanon	10/20/77	James Robert Smith, 42, & wife Pauline Jeffers Smith, 28 (both deceased)	Holly Hill Motel			2		gas stove	room	couple had moved one week earlier from Texas and had no permanent address - last seen 4 days earlier; fire marshal found ventilation problems in the gas heating stove in the room
IA	Clive	2/21/78	Jerry Tripp, 48, Helen Owens, 52, Marlene Debruyh, Mary Lance, 50, Steve Fuller, 28, Ruth Medici, 47, Kay Lavery, 35, John Llewellyn, 40 (all injured)	Sheraton	Y			8	furnace		victims were attending meeting in large first floor conference room of hotel; sick and some semi-conscious when fire dept arrived; high levels of carbon monoxide found; fire dept discovered malfunctioning furnace
MO	Springfield	5/28/78	Milan L, 44 (deceased) & wife Florence Lincoln, 44 (injured); Ben Yates, 88 (deceased - father of Florence Lincoln)	Ship and Anchor Motel			2	16	water heater		Police notified by hospital that two guests of motel had been admitted with symptoms of CO poisoning about 8am, hotel was then evacuated; 88 y/o man and his son-in-law found deceased; CO traveled thru ducts of hotel from broken/disconnected pipe; lawsuit subsequently filed alleging plumbing company installed water heater incorrectly; city did not inspect the unit, and owners of hotel did not make sure the water heater was working properly
CO	Estes Park	5/28/78	Margaret Amot, 27 (injured), Ester Maria Montoya, 36 (injured)					2	charcoal grill	room	victims built charcoal fire in room to cook hamburgers, then put grill in bathroom to burn out overnight - CO seeped under door; hotel staff alerted when one of the victims called for help after discovering her friend unconscious
SD	Rapid City	7/22/78	Frank McCune (injured) & wife Judith (injured) & 5 kids ages 8-15 (all injured)	Sands Motel				7	water heater	directly below victims' room	victims all woke up ill in the morning feeling groggy and nauseated; Fire Dept was called to investigate; Fire Marshal said "a defective ventilator to hot water heaters combined with poor ventilation in the boiler room and ceiling penetrations cause the fumes to back up and enter the bedroom above."
CO	Colorado Springs	12/22/78	Lloyd Michael Breilman, 22 (deceased)	The Casa Motel			1				victim found dead in room by hotel manager after no response to multiple phone calls
FL	Lakeland	1/13/79	Henry Hoagland (deceased)	Cozy Court Motel			1				victims found unconscious in their room by police officer looking to notify them that their car was illegally parked; space heater's intake and exhaust were clogged with ice formations which resulted in carbon monoxide flowing into the room. This also resulted in part from the eroded condition of metal sleeves through which carbon monoxide was discharged outside. The eroded sleeves permitted the carbon monoxide to escape through the concrete block walls to the ceiling and back into the room."
WI	Mauston	1/16/79	Susan Gilbert, 19 (deceased), Julianne Larsen, 20 (injured), Nina Hansohn, 20 (injured)	Towne Inn Motel			1	2	space heater	room	Fire Dept investigation found high concentration of CO in victim's room as well as multiple gas leaks in the heating system; owner quoted as saying he will have to tear hotel down because he cannot afford to make the necessary repairs to the pipes; many of motel's residents were long term tenants.
AZ	Tucson	1/27/79	24-year-old man (deceased)	Close-Inn Motel			1		heater		gas company shut off gas service to hotel "because of numerous gas leaks" found by the fire dept during an inspection ordered by city manager following death of man at nearby hotel (see case above # 1979-0205A2); most of the guests are long term residents
AZ	Tucson	2/5/79		Paradise Inn Motel							gas company shut off gas service to hotel "because of numerous gas leaks" found by the fire dept during an inspection ordered by city manager following death of man at nearby hotel (see case above # 1979-0205A2)
AZ	Tucson	2/8/79		Copper Court Motel							victim discovered deceased in bed by maid - she had opened the door the two previous days and saw the man's body in bed but thought he was sleeping, time of death determined to be these days above
TX	Fort Stockton	11/3/79	Johnny Ramos, 28 (deceased)	Gateway Lodge			1		wall heater	room	victim found by motel employee, deceased lying on floor of room at approximately 11:50am, time of death approximated at 1am
TX	Odessa	1/12/80	Joseph Earl Wynne, Jr., 28 (deceased)	Circle R Motel			1		wall heater	room	

IL	DeKalb	11/28/80	Michael McGrath, 26 (deceased)	Rice Hotel		1		water heater	basement	CO leaked into victim's room 2 floors above basement; found 9 days after he checked in; no CO found when body was discovered but pink discoloration of hands prompted blood test which confirmed CO poisoning. "The date of death was probably Nov. 20, because (victim) checked into the hotel on the 19th, and Northern Illinois gas shut off the gas to the building Nov. 21 when the hotel manager reported a gas leak"; CO "traveled through a hole around hot water pipes running from the basement to a radiator in his bedroom two floors above"
TX	Odessa	12/12/80	Richard Wayne Fletcher, 23 & Patti Marie Breckenridge (both deceased)	Traveler's Lodge		2		wall heater	room	victim's manager called manager of hotel when victim failed to show up to work or answer phone, manager subsequently discovered both victims dead in bed
TX	Brownsville	12/23/80	Patricia, 22 & husband Tom Navratil, 29, & their children, Amanda, 7 months (deceased), two other children, aged 2 and 4 (injured)	Del Mar Motel		1	4	stove	room	friend of family and hotel maid climbed in thru window when no response at door, discovered entire family unconscious; victims reported turning on the burners on the gas stove to keep warm; when room heater did not provide enough heat
MA	Newton	1/22/81		Holiday Inn	Y		24	water heater		"Boston Gas Co. officials suspect the poisonous fumes escaped from an improperly installed fire on a hot water heater." approximately 100 people were evacuated from the affected meeting room
AL	Montgomery	3/5/81	Alonzo Bradford, 1 (deceased) & mother Mary Bradford, 18 (injured), Robert Lee Moore, 34 (injured - companion of Mary Bradford)	St. Francis Hotel Courts		1	2	heater	room	Family found by hotel maid; little boy found on floor, his mother on bed, man on bathroom floor
OH	Brook Park	6/18/81	Robert Weaver, 29 (deceased)	Sheraton Airport Hotel	Y	1		pool heater		victim discovered by maid, "the heater for the swimming pool, the previous year when they closed it up for the winter, someone put a piece of plywood there, and all the fumes came up into this room"
FL	Bradenton	7/22/81	Ronnie Cornelius, 33 (injured) & wife Connie Cornelius, 28 (injured) & sons Eddie, 3 (injured) and Daniel, 9 (injured), & niece Celeste Jolkins, 11 (injured)	Holiday Inn	Y		5	charcoal grill	room	Family found unconscious in room by police who came to hotel after hotel clerk reported room was paid for using a stolen check connected to a purse-snatching incident a week earlier; father found sprawled on bed and rest of family on floor of room; parents were later charged with lighting fire in the grill in an attempt to kill themselves and the children.
SC	Orangeburg	1/1/82	Willie Harvey Brown III, 22 (deceased)	Carolina Wren Motel		1				Victim found deceased in room
TX	Odessa	5/30/82	Bernice Conner, 27 (deceased), Wayne Howard, 22 (injured), Danny Helms, 16 (injured), Ona Cangal, 16 (injured); also injured (no ages listed) were Leatetta Lawson & child Janet Vaden, Sandra Thompson, Shirley Miller, Jerry Voesting, Randal Crabtree (child), Joey Carlson, Billy Brannum (child), Gigi Dougan, Danny Helms (child)	Imperial Motel		1	13	water heater	room	Victims Conner and Howard treated for what was thought to be food poisoning in emergency room on May 29; police responded to call on May 30 and found Conner dead and Howard unconscious - three hours later they received another call that three more guests were found unconscious and subsequently found 11 more victims in various rooms; CO came from "a hot water heater vent pipe placed against a grating and not extended to the outside of the building"; Fire Marshal reported that two water heaters were inspected the prior December and one of the two was listed as a fire hazard due to no venting but inspector did not notice that the other heater was vented improperly; when the inspector returned on May 26 owners reported the heater with no ventilation was not in use - however, the heater with the faulty ventilation continued to operate due to the oversight; during investigation following the death city officials discovered the heater with the faulty ventilation was installed without a permit and had never been inspected; following incident, fire inspectors made plan to check every motel in Odessa
FL	Lakeland	12/21/82	Fredie S. Jones, 21 (deceased), Patricia Cromartie, 25 (injured)	Cozy Corner Motel		1	1	heater	room	Victims discovered in room by motel manager, man was on bed and woman on floor; investigators found vent pipe disconnected from heater and theorized it had been that way for some time as there was staining on the curtain behind it
IA	Tipton	12/30/82	Lanny Machovec, 34 (deceased), Bonnie Nielsen (injured)	Best Western Liberty Inn Motel	Y	1	1	fumes from smoldering insulation	adjoining room	Injured victim was in room below deceased victim's room; carbon monoxide came from smoldering insulation in ceiling of an adjoining room - resulting from short in heating system caused by leaky roof; CO entered victim's room via "holes left for installation of cables and wires in the fire wall" between his room and the adjoining room
TX	Del Rio	12/30/83	Orlando Gonzalez, 23 (deceased), Lydia Patino Cardona, 35 (deceased)	Palm Courts Motel		2		space heater	room	Victims discovered deceased in room by motel manager; fire marshal found illegal space heater in victim's room and another room; investigator said "a few years back a man died at the motel with similar surrounding circumstances"
PA	Edinboro	1/30/84		Holiday Inn	Y		27			most of the victims were high school students attending a DECA convention; CO was found in rooms in a second floor wing of hotel; inspector with gas company theorized there was either a hole in the ventilation system or "the system wasn't ventilating high enough in the air"
CA	San Jose	2/3/84	Bas Seung Hoon, 37 (deceased), Chea Song Pak, 37 (injured)	Wagon Wheel Motel		1		heater	room	Victims discovered when they failed to check out of room; authorities thought they were suffering from food poisoning - cause/reason for death not discovered until another fatality in same room two days later - see case # 1984-0203CA listed below
CA	San Jose	2/5/84	Dave Swafford, 30 (deceased)	Wagon Wheel Motel		1		heater	room	Victim discovered deceased in same room as another guest found two days prior - see case # 1984-0203CA above; CO measured at 125ppm in room; another room in hotel also found to have faulty heater

AZ	Tucson	2/10/84	Debra Deluca, 26 (deceased), & daughter Jolene Deluca, 4 (injured), Bernard Franklin Winnie, 46 (injured)	Pine Wood Motel		1	2	1 Injured	heater	room	friends alerted hotel staff when the three failed to answer door; found mother deceased and her child and boyfriend semi-conscious; gas company found CO leaking from improperly vented gas heater
CA	Hollywood	7/12/84		Ramada Inn	Y		34		heater		paramedics responded to hotel for sick person, called back for a second sick person and noticed a gas odor so called for additional units; hotel evacuated; CO dispersed throughout hotel thru air conditioning vents; CO levels at 200ppm
NM	Albuquerque	12/22/84	Dou T. Wilson, 31 (deceased)	Nob Hill Motel		1			heater		subsequent lawsuit filed on behalf of victim alleged that boiler service owner failed to properly install and provide ventilation for a space heater as well as failed to inform the motel that he was not qualified nor licensed to install the heater
NC	Winston-Salem	1/16/85		Ramada Inn	Y		30				motel employees and some guests began losing consciousness in area around the kitchen around 7:30pm, hotel air checked for CO approximately 90 minutes later when doctors discovered high levels of CO in victims; injured included 13 firefighters and police who rushed in to help; guests were evacuated to an emergency shelter; a private engineering firm hired by the hotel attempted to find a source for the carbon monoxide, which was found in heavy concentrations in some of the 30 people taken to hospitals. They theorized that carbon monoxide produced by the hotel furnace or by traffic on US 52 and nearby businesses became trapped near the ground and in the hotel lobby because of temperature differences between the ground and the layers of air above it. The carbon monoxide could then have been channeled into the hotel's ventilation system.
MA	Boston	2/22/85		Howard Johnson 57 Park Plaza Hotel	Y		55		water heater	6th floor	"malfunction in the boiler allowed fumes to seep into sixth floor conference rooms"; 23-story hotel; hotel evacuated after guests began passing out from fumes; complaints from guests and meeting attendees that there was no evacuation plan and they were not informed of the reason for the evacuation, "switchboard operators were denying to callers seeking information that any problem existed or that an evacuation occurred"; two separate conventions in process - approx 350 people attending a lawyers convention, one of the attorneys said the group had been discussing insurance coverage dealing with toxic materials
NC	Statesville	3/12/85	Emma Mae Lindsay (deceased) & son, James Lindsay III (injured)	US 21 Motel		1	1		heater		victims discovered by motel owner; referenced heater was "last manufactured in December of 1961"
NV	Las Vegas	7/5/85	Booker Anderson, 45 (deceased), Robert Shoemaker (deceased)	Crest Motel		2	18		water heater	1st floor utility room	CO spread to one wing of the hotel; deceased victims were found in adjoining rooms near the water heater around 9:30am; some of the other victims were found unconscious; fire chief said "it appeared that the carbon monoxide had been building up for three or four days"; "City building inspectors said the water heater, which was installed without a permit since the motel was last inspected in April 1984, was larger than the unit it replaced and because of that was not properly vented"; "A couple staying at the motel said they were moved from room 137, where one of the dead people was found, two days earlier after becoming sick"; "The downtown motel rents rooms by both the day and week and houses some downtown hotel workers. Many of those staying at the motel were elderly tourists."
TX	Amarillo	10/5/85	Comellus Hatten Jr., 24 (deceased), Tommy P. Barker (deceased)	The Sands Motel		2	12		generator		victims discovered by their employer around 8:30am when they failed to show up for work; employees said generator was being used after utility company cut off electricity to the motel due to unpaid bills; CO fumes from generator spread to other rooms; city inspectors condemned and dosed motel after deaths
KS	Lenexa	12/6/85					11				hotel evacuated after CO fumes spread to north wing of motel rescue workers dispatched to motel at 7pm and again at 3am to treat guests complaining of breathing difficulties, did not immediately suspect CO: earlier around 5:30pm a hotel employee called boiler company because boiler was leaking (boiler company reported hotel told them repair could wait till morning); one of the injured guests remembered going to bed around 12:30am not feeling well and then woke up in an ambulance sometime later that morning; bodies of deceased victims were found at 4:30am by a janitor who saw water leaking from ceiling below deceased woman's room-she was found submerged in bathtub with water still running and her fiance was unconscious on hotel room floor; male decedent was found in adjacent room; CO cause determined to be due to high winds backdrafting fumes into hotel rooms due to an "obsolete" heating system that was 20 years old
VA	Troutville	1/14/86	Suzette Passionno-5 months pregnant, 21 (deceased) & fiance Anthony Storti, 31 (injured), Arthur B. LeBlanc, 46 (deceased)	Best Western Coachman Inn	Y	2	8		boiler		boiler had a bad seal and was directly under air conditioning duct causing CO to leak into air conditioning system; hotel evacuated; CO levels measured at 200ppm; victims reportedly included two pregnant women
NJ	Hackensack	1/19/86	Jesse Davenport, 54 (deceased), Alvon Harrison, 23 (deceased)	Airport Motel		2			heater		cochine overdose, a lawsuit filed two years later charged that their deaths were a result of a faulty heater based on the state medical examiner's toxicology report which showed that both victims "had many times the normal level of carbon monoxide in their blood at the time of death...enough to kill both of them"; after reading the news story about the lawsuit, the hotel's former maintenance man came forward and said the hotel owner had ordered him to install the gas heater the day after the deaths
NV	Wendover	8/19/86		The Stateline Hotel and Casino			30		boiler		

IN	Nashville	11/23/86	John, 61 (deceased) & wife Joan, 67 (injured); Spaulding, Earl; Shelburn, 64 (injured); John, 63 (injured) & wife Frances, 65 (injured) Gleeves	Opryland Ramada Inn	Y	1	5	pool heater	adjacent to victims' rooms	victims discovered in their room around 12noon when man failed to show up at a convention meeting, he was deceased on floor and his wife sprawled on bed sick and disoriented; room to room search found several other disoriented guests who were taken to hospital; hotel not evacuated till 10pm, when autopsy showed man died of CO poisoning; illness of other guests originally suspected as food poisoning; hotel was 18 months old and "the 308-room hotel was allowed to open with a temporary use and occupancy permit"; Health Dept Director said, "the design of the ventilation system for the swimming pool and the equipment room created a situation that caused carbon monoxide to build up in the pool equipment room and to filter into other rooms in the hotel...in addition, a gas water heater may have been defective"; this case was the subject of a JAMA article published in 1989, "Fatal Carbon Monoxide Poisoning at a Motel"
ME	McClellan	12/28/86	Darrell D. Jones, 49 (deceased)	Economy Motel		1		heater	room	victim discovered deceased in room by motel staff; high levels of CO found in room; heater was found to have a defective vent; on autopsy, victim appeared to have died of a heart attack but due to CO found in room toxicology was ordered and 3 1/2 months later confirmed he had died of CO poisoning with a blood CO level of 43%
HI	Wilea (Maui)	1/22/88	Constancio Alvidio, 61 (deceased)	Maui Intercontinental Wailea Hotel		1	9	generator	basement	deceased victim was employee of hotel; discovered unconscious near trash compactor in basement - ambulance responded to "an apparent heart attack"; rescuers discovered two additional victims lying near first victim - three other employees collapsed in nearby employee locker room "prompting an evacuation of the area that includes a service tunnel, loading dock and the compactor room"; multiple first responders ill at scene - 4 required treatment at hospital; 20 minutes prior hotel had been testing the emergency generator - exhaust pipe was vented into the trash compactor room; according to police, "generator was run from about 1pm to 1:35pm...Alvidio was found unconscious at 1:52pm...exhaust vent is located near the doorway of the trash compactor room"
AR	Mountain View	1/24/88	Mary Umpleby, 36 (injured) & granddaughter Chastity Wilson, 2 (deceased); & son Garrett Long, 14 (deceased) & friend James Robin, 25 (injured)	Mountain View Motel		2	2 deceased	heater		Medical Examiner determined cause of death to be CO poisoning by gas heater in the room; Director of LP Gas Board said an inspector "tested the heater twice...did not find it to be operating improperly"; a state police investigator considered the case closed and was "satisfied there was no foul play...tests by an inspector for the state LP Gas Board don't mean there was nothing wrong with the heater at the time of the deaths"
FL	Miami Beach	4/6/88		Fontana Hotel			42	boiler		CO spread thru air conditioning system; rescuers called to hotel for guest who had passed out and found many others complaining of CO symptoms; CO levels measured at "300 times what is considered normal"
CA	Hayward	11/6/88	Michael Horvath, 33 (deceased) & fiancée Glona Burroughs, 34 (deceased)			2		water heater		
MT	Saltese	11/23/88	Bruce, 28 & Colleen, 29 MacMaster (both deceased)	4-D's Motel		2		heater	room	heater found to be improperly vented; "heater should have been vented up a chimney instead of horizontally out a wall"; heater had been installed by hotel owners without a permit; investigation found that other people who had stayed in the same room prior to incident had also been ill
AZ	Mesa	2/8/89	Family of 4: Al Shernberg 26, Sandra Magness 25, & daughters Amanda 18 months and Jessica, 8 months (all deceased)	Florian Motel		4	2 deceased	1950's-era gas heater		employee found bodies of family along with their dead German shepherd; fire dept found room's heater not connected to a chimney; motel built in 1933
CT	Windsor Locks	10/31/89	Sharon Matos, 33 (injured)	Motel 6	Y		1	dryers	laundry room	hotel opened 9 weeks earlier; victim was employee of motel, began feeling dizzy and collapsed in laundry room; on 10/25 two other workers were taken to the hospital after becoming ill in the same room - hotel owners called gas company after incident but gas company did not detect CO or other gases; one of the two workers went to the hospital again in two days later and was found to have elevated CO levels in blood; OSHA inspector responded after employees filed complaint; on 11/1 town building inspector detected CO in laundry room and engineers determined "that a down draft caused by low-flying airplanes was probably forcing exhaust containing the poisonous gas back down the flue into the room"; hotel subsequently installed fans in the exhaust pipes of the two dryers in the laundry room
SD	Rapid City	11/18/89	Steven Beach, 38 (deceased)	Dakota Motel		1		furnace		victims discovered deceased in rooms 1227 and 126 a day apart; CO not suspected with first victim because according to conner he "didn't show the classic signs" of CO poisoning and death was ruled as natural; investigation ordered when second man was discovered deceased the following day; a woman in room 1211 had complained of nausea and "an odd odor" in her room; investigation showed CO came from a single gas furnace that supplied heat to rooms 121-126; motel was 30 years old and had never been inspected; CO exposure thought to be a result of "back drafting" - motel manager re-lit pilot light when victim Russell complained of being cold but neglected to replace the front panels of the furnace - "exhaust gases could have been pulled from the system back into the cold air return on the bottom of the furnace...obscuring the air in the rooms"
SD	Rapid City	11/19/89	Eugene Thomas Russell, 25 (deceased)	Dakota Motel		1		furnace		firefighters called to motel when fumes set off an alarm - natural gas was shut off and hotel closed until source of CO could be determined
OH	Fairawn	1/4/90		Days Inn	Y					

IN	Evansville	1/25/90			Radisson Inn	Y	14				group of conventioners began feeling ill; county health officials could find no problem; highest level of co found in patients was 32%; victims all in wing of 16 rooms on 1st floor "where inside windows overlook an enclosed area with a swimming pool"
KY	Jefferson County	2/3/90			Brownsboro Inn		34	boiler			two of three wings of hotel evacuated after guests awakened smelling ill around 7am; 24 guests transported to nine hospitals; investigation found broken boiler not properly reassembled by the repair crew that had worked on it earlier in the week - stack was loose as well as 3 2/4" x 6 1/2" x 1/2" bolt in the front of the boiler; stack was disassembled by workers who found the boiler had been repaired improperly; most guests arrived and returned to their rooms; guests who thought they had food poisoning; hotel manager called for help at 6am; 7 guests transported to hospital - 2 flown by helicopter to UCSD Medical Center in San Diego for treatment; 8 of the victims treated in hyperbaric chamber; 12 firefighters; 1 police officer and other guests were hospitalized; "the cogenerator's exhaust system failed and carbon monoxide reached the hotel lounge above"
CA	Fallbrook	4/7/90			La Estancia Inn		20	propane-powered cogeneration unit	3 injured	basement	guests who thought they had food poisoning; hotel manager called for help at 6am; 7 guests transported to hospital - 2 flown by helicopter to UCSD Medical Center in San Diego for treatment; 8 of the victims treated in hyperbaric chamber; 12 firefighters; 1 police officer and other guests were hospitalized; "the cogenerator's exhaust system failed and carbon monoxide reached the hotel lounge above"
MI	Watermeet	6/16/90			Arrow Lodge Resort		5				EMS called around 8:30pm; a guest who was sick; when they arrived discovered multiple people ill; some unconscious; firefighters did "room by room sweep"; fire depts and ambulance crews from five neighboring towns were called in to help; local hospital called in 50-60 additional personnel; hotel employees had been ill with headaches and dizziness in days prior; injured included guests, firefighters and employees; subsequent investigation found "swallows" nests choking pool heater vent
MI	Spicer	7/1/90			Cazador Inn		120	pool heater			motor workers found two of the victims unconscious in the pool area; faulty pool heater vent stack leaked carbon monoxide through louvers in a door adjoining the pool
MI	Lansing	9/18/90			Ramada Inn	Y	3	pool heater	1 injured	room next to pool	swimming pool boiler vent system failure; hospitalization of hotel guests
CO	Silverthorne	7/7/1990			Silverthorne Comfort Inn	Y		pool heater			visited on Dr. Weaver's spreadsheet; source listed as Colorado Springs Gazette - unable to find further information online
CO	Pueblo	7/7/1990									victims were discovered about 2:30pm after friends could not get answer at door, contacted hotel security who broke a window to gain entry to room; building inspector said heater in room appeared to be original to the building which was constructed in early 1960s; venting system also clogged with soot so natural gas heater was working poorly; following the incident, the Building Inspection Dept found violations in 83 of the 190 rooms inspected, including malfunctioning heaters in 36 of the rooms; victims were members of the Southern Alberta Institute of Technology's men's volleyball team in town to play four exhibition games; Chairman of the city's Public Services and Safety Committee; "it's tragically been brought to our attention. I'd like to see how the Hotel-Motel Assn. could assure the city and public that there are hotels and motels that are not only beautiful, but safe."; city building inspectors and the San Diego County Hotel & Motel Association reported they would jointly send out letters to all county hotels and motels to remind owners and operators of "the obligation to properly maintain all mechanical equipment"
CA	San Diego	1/1/91			Mission Valley Inn		1	wall heater	1	room	victims reported feeling nauseous and dizzy after spending time in the pool area; CO leaked from improperly installed ventilation system; CO levels at 450ppm
WI	Stevens Point	11/8/91			Comfort Suites	Y	72	pool heater			victims discovered around 3pm by hotel staff; "it is not clear how long the units were exposed to fumes from the hotel's gas-fired boiler...by the time the housekeeper discovered them and called for help, the gas had spread to three floors"; hotel employee collapsed while inspecting the boiler room; CO levels were measured at 210ppm on the second floor; a state fire investigator "determined that leaks and closed vents in a hotel boiler system produced high levels of carbon monoxide...maintenance workers knew about leaks and tried to seal pipes with duct tape"; "Gas apparently leaked into a third-floor room...through an exhaust duct connected to four boilers on the floor below. Two pipes carrying cold water to air conditioners in the students' room ran through the duct. Leaks around the pipes allowed the gas to seep through"; "vents allowing air into the boilers were closed, which caused the water to back up, overflow, and leak into the carbon monoxide leakhead of air"
FL	West Palm Beach	3/21/92			Holiday Inn - Airport	Y	4	boiler		second floor (below victims' room)	CO found in 24 rooms; improperly installed laundry room fan cause CO from water heater to disperse into rooms;
TN	Knoxville	5/14/92			Family Inn		10	water heater			multiple calls to 911 by guests feeling ill beginning at 6:21am; fire dept evacuated hotel and discovered malfunctioning heater
CA	Indian Wells	12/12/92			Stouffer Emeralds Resort		8	heater			visited on Dr. Weaver's spreadsheet; source listed as News & Observer - unable to find further information online
NC	Durham	7/7/1992			Cricket Inn						problem identified when "hotel maintenance workers were in the basement...trying to correct a water temperature problem after a guest's complaint when they began to complain of nausea and headaches. Fire officials were then called in and discovered the build-up of carbon monoxide"; 25-story hotel evacuated; victims hospitalized included hotel employees who tried to fix leak; "officials said the bitterly cold weather probably caused the boiler to back up with carbon monoxide"
MA	Boston	2/7/93			Back Bay Hilton	Y	6	boiler		basement	

TN	Nashville	3/24/93				Doubletree Hotel	Y		16		boiler		outside air ducts were blocked and employees had propped open doors to boiler room. large ventilation fans had been turned on in the adjoining room which created a vacuum pulling the boiler exhaust back down the pipe and into the hotel; "system is similar to the systems in most large buildings in Nashville, but some have an added safety device. For the last five years, boiler systems have been built with sensors which automatically shut down the system if they detect carbon monoxide. The Doubletree, built in 1979, does not have such a system."
TX	Arlington	3/27/93	Edward Burner Anderson, 54 (deceased)		Days Inn	Y	1	40	1 injured		water heater	room next to deceased victim's room	fire department to enter multiple times beginning at 3:40pm by guests in room severe headaches and stomach upset, eventually discovered high levels of CO throughout hotel and evacuated rooms via door to door notification of guests; Fire Dept spokesman reported CO poisoning was not originally suspected because patient "did not have the rosy complexion that often accompanies the ailment"; CO levels measured at 500ppm; deceased victim unable to evacuate and was discovered deceased on bathroom floor of his room by city health inspector 5 hours later (subsequent formal inquiry/report regarding evacuation procedure was completed by Fire Dept and reviewed by city officials); guests not informed of why they were being told to evacuate; CO leaked from "ruptured" water heater vent pipe that was blocked by debris; "CO poisoning was not suspected until 3:40pm when the hotel evacuated"; worker whose office was located in basement was hospitalized; "fumes escaped while a (carpet cleaning crew) operated steam-cleaning equipment in a first-floor ballroom...machinery was powered by a gasoline engine on a truck parked in a hotel loading bay, and exhaust fumes backed up after a hose connecting the cleaning equipment and the truck became obstructed"
IN	Evansville	9/7/93			Executive Inn			2			carpet cleaning equipment		police called to hotel after receiving reports of "an usual odor" and discovered victims, appeared to have been dead for some time, checked in six days prior; man found on floor near bed and woman lying back in chair
UT	Salt Lake City	12/10/93	Samuel Doan, 83, and Madalyn Jerreb, 53 (both deceased)		Holiday Motel			2			heater	room	couple woke up with headaches and breathing problems and called 911; fire dept detected "potentially lethal levels of carbon monoxide" in the room
AZ	Mesa	1/9/94	Geraldine Tate, 62 & Cecil Constable, 77 (both injured)		Starlight Motel			2			heater	room	victims were owners of the motel and lived onsite; found in living quarters adjacent to motel office; man found on bed, woman on floor; no guests staying at motel during evening of incident; authorities found no defects found in gas furnace but theorized high winds and snow may have caused downdraft that trapped CO in room
IA	Mason City	2/26/94	Donald Easton, 68 and Michiko Walton, 53 (both deceased)		Colonial Inn			2			furnace		motel guests complained of feeling ill; taken by ambulance to hospital where diagnosed with CO poisoning, hospital alerted fire dept who then evacuated motel; CO levels reached 400 ppm in some areas of hotel; firefighters obtained list of occupied rooms from hotel and evacuated all occupied rooms - list did not include Ms. Meister, she was found unconscious two hours later when firefighters performed room by room search; subsequent investigation determined "hotel maintenance workers walked off the boiler that heated the pool after fire inspectors cited the motel for having papers in the same room as the boiler. That caused the boiler to create carbon monoxide that seeped into the motel's ventilation system and into the bathroom vents on the same level as the boiler"
IL	North Aurora	10/20/94	Joanne Meister, 42 (injured)		Super 8	Y		10			pool heater		around 6:30am a family of five at hotel called 911 thinking they had food poisoning, later other callers reported similar symptoms; emergency responders became ill as well; malfunction of one of three furnaces in basement, CO leaked into three rooms on second floor
MD	Ocean City	11/26/94			Princess Royale Hotel			24			furnace	basement	*listed on Dr. Weaver's spreadsheet, source listed as Fort Worth Star Telegram - unable to find further information online
TX	Irving	7/7/1994			Red Roof Inn	Y							Blank's friends asked hotel to check room when he did not show up, maid found him deceased and Ream unconscious in their room (317 - located on first floor of guest rooms); Kinder was in 417 directly above them and was found conscious but ill; fire dept measured CO levels of 250ppm in 317 and levels exceeding 400ppm in the boiler room where the water heater was located; leak was traced to a "small auxiliary water heater"; hotel manager reported they would install CO detectors immediately; several guests reported that they were not notified of the problem until "hours" after men were found and that only nearby rooms were evacuated; Blank and Ream both reportedly thought they were ill with the flu
FL	Tampa	2/2/95	Ronald Blank, 51 (deceased), James Harold Ream, 37 (injured), Steve Kinder, 51 (injured)		Embassy Suites Hotel	Y	1	2			water heater	two floors below victims' room	victims checked in Friday evening, found unresponsive in room at 12:30pm on Sunday; "carbon monoxide was produced by a gravity-vented wall heater...manufactured in the late 1950s...the heater was allowed to operate with the heat exchanger detached from the draft diverter, causing the flue products to spill into the living area"; Molly's sister, Lyrysa Smith, published book about her recovery in 2013 "A Normal Life"
CA	Mammoth Lakes	2/10/95	Walt Weber, 42 (deceased) & wife Molly Weber, 36 (injured)		North Village Inn			1	1		heater	room	"dangerous levels" of CO were found on the motel's top three floors
VA	Virginia Beach	8/7/95	Larry Corbett, 25 (injured)		Murphy's Emerald Isle Motel			44			furnace	room	man found dead in room; coroner investigation showed CO poisoning resulted from a "dirty heater"
CA	Sacramento	12/9/95	Ferrel Bradbury, 79 (deceased)		Forty-Niner Motor Lodge			1	1		heater	room	*listed on Dr. Weaver's spreadsheet, source listed as Rocky Mountain News - unable to find further information online
CO	Fort Collins	7/7/1995			Holiday Inn	Y							*listed on Dr. Weaver's spreadsheet, source listed as Lexis Nexis Legal - unable to find further information online
IL		7/7/1996			Budgetel Inn								*listed on Dr. Weaver's spreadsheet, source listed as Lexis Nexis Legal - unable to find further information online

KY	Danville	1/28/97	Julianne Boise, 30, Charles Baughman, 47, James Filipiak, 46, Chad Cooper, 26, Linda Schultz, 46, & daughter Jennifer Schultz, 17 (all injured)	Holiday Inn Express	Y		6	1 Injured	pool heater		CO escaped up thru a broken exhaust pipe for the pool heater and thru a ceiling opening around a pipe, then to exhaust vents of the hotel rooms' bathrooms, discovered when a frequent guest of the hotel did not respond to a wake up call and was found unconscious in room, two other guests came to front desk complaining of feeling faint; CO levels measured at 70ppm in lobby, "additional readings in hotel rooms were as high as 600ppm and above"
CA	Daly City	2/20/97	Clarence D. Brown, 46, Mildred K. Allen, 41, & daughter Talisha Brown, 2 (all deceased)	Alpine Motel		3		1 deceased	heater	room	victims discovered deceased in room by maid - woman and child on bed, man on floor; investigators reported that vent for room heater was blocked but unable to determine for how long; heater removed for further testing; motel had minor health and safety violations - "inspections check to see if heaters produce heat, but do not check the internal systems"; guests who stayed in room three days earlier had headaches and "found it difficult to wake up...while staying there"
MT	Somers	3/15/97		Ramada Inn	Y		8		pool heater	room adjacent to hot tub	victims were in hot tub and began having headaches, nausea and weakness, one lost consciousness in hot tub and another went to call 911; CO found leaking from rusted out section of exhaust pipe, "fans designed to ventilate and expel humidity from the pool room then pulled in the deadly gas through the vents in the door separating the hot tub area from the boiler room"
IA	Ottumwa	8/16/97		Parkview Plaza			4				4 members of family staying on top floor went to hospital complaining of headaches and dizziness; hospital alerted police and fire who found high CO levels on every floor and evacuated hotel
TX	Arlington	7/7/1997		Adlington Hilton	Y						*listed on Dr. Weaver's spreadsheet, source listed as Fort Worth Star Telegram - unable to find further information online
IL	Peoria	7/7/1997		Mark Twain							*listed on Dr. Weaver's spreadsheet, source listed as Journal Star - unable to find further information online
FL	Fort Walton Beach	8/4/98		Marina Bay Resort			20		boiler		family of four went to hospital complaining of headaches and nausea, doctors diagnosed CO poisoning and called fire dept; fire dept found other guests ill and evacuated hotel
FL	Clearwater	9/9/98	Kenneth Vaughan, 34 (injured) & wife Cheryl Vaughn, 32 (injured)	Quality Inn Beach Resort	Y		3		water heater	first floor	victims awoke feeling ill in the afternoon and called 911 thinking they had roof poisoning but were disoriented; responders quickly determined they were suffering from CO poisoning and pulled fire alarm to evacuate hotel; other victim was a paramedic; Fire Chief reported "a clogged vent from a natural gas water heater on the first floor caused the problem. CO from the vent seeped out at the roof level and leaked into the Vaughn's room on the fifth floor....CO was also found in other areas of the hotel but highest level was in the area of the Vaughn's room." CO levels measured at 180-200ppm
VA	Virginia Beach	12/16/98		Murphy's Emerald Isle Motel			2		boiler		prior incident at this hotel 8/7/1995 (see case above); authorities were called when "several boxes of carbon monoxide detectors in storage in the boiler room went off due to a faulty flue pipe in the boiler"; "...not clear whether the same furnace caused the problem in 1995"
IA	Mason City	1/11/99	Bruce & Bobbi Hollowell & their 2 children; Duane & Marjorie Dannen & their 3 children; Echo & Steve Cash; Terry & Jill Black & their 2 children; Debra Lugar & her 2 children	Comfort Inn	Y		19	9 Injured	pool heater		fire dept notified around 9pm when two children became ill and were diagnosed with CO poisoning at the hospital; multiple families ill with headaches and vomiting; fire dept evacuated hotel, measured CO levels at 668ppm in pool area; victim described event, "it was chaos"; CO found to be leaking from "faulty exhaust system"
NY	Manhattan	7/3/99		Crowne Plaza Hotel	Y		11	1 Injured	sandblasting machine	basement	CO spread to parking garage and lobby; 3 construction workers and an 11 Y/o girl taken to hospital, 7 others treated at scene; sandblasting machine was being used to remove paint in basement of hotel
MA	Yarmouth	10/6/99		West Yarmouth Inn			24	11 Injured	clogged heating unit		CO heater discovered after family of 3 went to UK complaining of roof poisoning around 8am - doctors diagnosed CO poisoning and alerted fire dept who found 8 other residents in "various states of distress, including an unconscious 3 year old"; injured victims included two pregnant women; CO found in 10 of hotel's 34 rooms; higher levels of poisoning found in those who had turned on heat in their room; incident led to discovery of multiple families (including 44 school-age children) living at that hotel and other hotels in the area because
IN	Merrillville	8/11/00	Injured included: guests Joseph Toppor, 48 & wife Amy, 27, hotel employees Roshanda Hinton, Nicola Sindair, 34, Barbara Grubbs, 58	Holiday Inn Express	Y		24	15 Injured	pool heater		CO heater discovered after family of 3 went to UK complaining of roof poisoning around 8am - doctors diagnosed CO poisoning and alerted fire dept who found 8 other residents in "various states of distress, including an unconscious 3 year old"; injured victims included two pregnant women; CO found in 10 of hotel's 34 rooms; higher levels of poisoning found in those who had turned on heat in their room; incident led to discovery of multiple families (including 44 school-age children) living at that hotel and other hotels in the area because

NY	Amsterdam	10/11/00	Ursula & Richard Vasieck; Pentz family; Calvin & Marietta and their children Calvin Jr., 6, and Kristina, 10 (all injured)	Amsterdam Best Western	Y		12	2 injured	pool heater			mother of family affected was awakened at 3am by the sound of a passing train and realized she was "violently sick"; she woke up family members who were all feeling same effects - called front desk who called 911; firefighters evacuated hotel and found Vasieck couple - she was unconscious and he was semi-conscious; "Health Department investigators concluded that the heater had been improperly maintained, causing the carbon monoxide leak." - hotel fined \$500; CO detection system was installed following incident
CO	Denver	11/1/00	Eric Potteiger, 30 (injured), Amy Bronn (injured)	La Quinta Inn	Y		6		pool heater		ground floor	housekeepers found unconscious guest on 2nd floor at 11:40am, firefighters responded and while there, housekeepers found another guest found unconscious on 3rd floor; firefighters did room by room search for more victims; around 4:30pm the cause of the CO was determined to be pool heater's exhaust system not operating properly; "A police report attached to the federal lawsuit quotes a hotel manager as saying that, while rescue authorities were responding, La Quinta's legal department told employees to deny any knowledge of any sick or ill people"
WI	Eau Claire	11/5/00		Days Inn	Y				dryer		near swimming pool	CO detector activated around 7:00pm; motel evacuated for approx 30 min; source disclosed
IA	Davenport	12/15/00		Days Inn	Y		4		furnace			Fire Dept called to hotel around 8:30pm, detected "high levels" of CO in pool area and "entranceway"; 4 people taken to hospital for treatment
TX	Georgetown	12/28/00		Holiday Inn	Y		4		water heater			around 11:20 am, a victim called 911 after becoming ill with nausea and dizziness; CO leak detected by first responders who evacuated hotel
IL	Effingham	2/16/01		Lincoln Lodge Motel			10		furnace			2 guests transported to hospital around 3:30am, doctors diagnosed CO poisoning and notified Fire Dept who returned to hotel at 4:41am and discovered eight additional victims who were taken to hospital; high levels of CO found in 5 rooms
TX	Odessa	3/27/01		Best Western Garden Oasis	Y		1					hotel employee ill and went to hospital; hospital diagnosed CO poisoning and notified the fire dept; "fatal levels" of CO found in areas of second floor, biggest accumulation was in a conference room; Asst Fire Chief, "it's unusual to find this much gas and only one person sick"
WY	Teton Village	8/2/01	David, 51 (deceased) & Joette Williams, 50 (injured)	Snake River Lodge & Spa		1	1		boiler		below victims' room	Victims discovered about 10:00 am in their room in the morning; man over water same day at the hospital, woman flown to Pocatello, ID for treatment in hyperbaric chamber; victims had been taken to emergency room from hotel the day before with symptoms including nausea and diarrhea, treated for dehydration and then discharged, returned to hotel room; subsequent investigation found room CO levels at 770 ppm; "gases from the first-floor laundry room, which housed some of the hotel's dryers, water heaters and boiler units, were released through a vent...int from the laundry room was plastered to air conditioning units in several rooms....int from the laundry room, which operated by sucking air in and cooling it, likely pulled in carbon monoxide gas after it was emitted from the laundry room"; a safety switch on a water boiler had been disabled - the switch which was to shut boiler off "if proper combustion did not occur" - switch disabled because it interfered with hot water production at the hotel; reports of both guests and employees
NM	Monahy	11/18/01		Lariat Motel		1	1				room	2 guests found in their room, one deceased and one unconscious, by motel workers around 10am when they failed to check out
MA	Palmer	7/7/2001		Kings Inn								*listed on Dr. Weaver's spreadsheet, source listed as Union-News Springfield - unable to find information online
CA	Ventura	7/7/2001		Mission Bell Motel								*listed on Dr. Weaver's spreadsheet, source listed as Ventura County Star - unable to find information online
NM	Carlsbad	7/6/02		Park View Motel			2					two victims were women found unconscious in room couple had stayed at resort many times previously; owner noticed he had not seen them and went to check on them around 12noon - found body of husband in the kitchen/living area and left to call 911; fire dept reported CO levels at 248 ppm and found corroded furnace vent pipe, abandoned chimney
WI	Chetek	8/21/02	Frank Hekenberger, 81 & wife Catherine Hekenberger, 85 (both deceased)	Northland Resort		2			furnace			*listed on Dr. Weaver's spreadsheet, source listed as Times Union - unable to find further information online
NY	Albany	7/7/2002		Holiday Inn								hotel owner knew the heater was broken and gave the couple an electric heater to use - husband thought he fixed the heater so turned it on; stillborn's death determined to be from CO poisoning
AZ	Flagstaff	1/8/03	Jack Foster, 31 & Jeanette Launer, 25 (injured) - she was 8 1/2 months pregnant and delivered stillborn baby after being transported to hospital	Paradise Motel		1	2	1 deceased	well heater		room	problem identified when guests became ill; investigation discovered crack in the chimney of the hot water heater; high levels of CO spread thru "attic, walls, and ceilings"; owner installed CO alarms following incident
NH	Lincoln	8/6/03		Indian Head Resort			27		water heater			Family had been in pool for 15 minutes and all began feeling ill - all got out, boy passed out and fell in pool, father collapsed; fire dept responded and found CO levels of 1600ppm in pool room and faulty vent for pool heater; hotel installed CO alarms following incident
KS	Salina	9/16/03	Rivers family: Roslyn, 36, Robert 41, Adam, 10 and Alexis, 9 (all injured)	Holiday Inn Express	Y		4	2 injured	pool heater			

MA	Danvers	9/17/03											4 victims were maintenance employees of hotel - 2 were found unconscious on the floor of the boiler room when they had been out of contact for an unusual amount of time; hotel evacuated, consider outside of boiler room measured CO levels at 900 ppm, failure of pool heater vent system
MO	St. Louis	12/18/03											fire dept called when 2 laundry room workers became ill around 11am; found elevated levels of CO in basement and evacuated guests
WY	Jackson	1/17/04											three guests called front desk reporting rapid heart rate, dizziness and lightheadedness - hotel called 911, "Firefighters determined that the gas escaped from a broken connection in two pipes leading from the motel's boiler beneath the rooms where the victims were staying" - theorized that pipe may have been broken due to a 5.0 magnitude earthquake that hit area on January 7; Fire Dept measured CO levels at 300ppm in victims' room who had the most exposure - those victims were flown by helicopter to hospital in Pocatello, ID for treatment in a hyperbaric chamber; hotel installed CO detectors in "all areas of combustion" following incident
AZ	Kingman	2/14/04											Couple checked into suite on 2/13; at about 7pm on 2/14 "management found a deceased female in a bathtub and a male who was not responsive on a couch"; CO levels in room measured at 420ppm; surviving victim was flown to Barrow Neurological Institute in Phoenix in critical condition; "nickel sized holes in the boiler's exhaust pipe" were found; according to subsequent lawsuit filed, the installer of the jacuzzi tub in bathroom "failed to properly caulk or otherwise seal the holes...creating a common airspace between room 240 and the boiler room"
IN	Indianapolis	6/9/04											Westlaw: Perreault v. Prime Hospitality Group 2006; Raymond v. Prime Hospitality Group 2006; complaints state that both victims were guests at the hotel and suffered CO poisoning caused by CO seeping into their rooms
NJ	Newark	7/7/04											hotel employees called 911 when guests complained of feeling faint - "shortly before the datter of in-room carbon monoxide alarms signaled that something was wrong"; high levels of CO in upper floors; firefighters unable to find source, called HazMat team who found "elevated carbon monoxide levels from the vaporizing of PCB-laden insulation on the transformer's wires"; transformer located in a separate building - fumes spread thru hotel ventilation system, "more fumes were created when other electrical wires sized inside walls between the rooms"; six story hotel; hotel windows don't open so difficulty cleaning building of CO
NH	Lincoln	8/29/04											Desk clerk became ill and called 911; EMS responded and "recognized potential CO exposure and notified Fire Dept along with evacuating the building"; CO levels measured at 400ppm; "Prevailing winds coupled with heavy damp air moved CO from the rooftop vent across to the air intake for the building. CO found on all levels. Possible cause due to environmental conditions. CO lingered on the roof and was drawn in by the fresh air intake."
SD	Yankton	12/23/04											man, woman and 5 y/o child experiencing headaches and nausea around 3am; emergency crews responded and found unconscious woman in another room; "exposure was caused by a furnace drawing exhaust fumes back into the building. Carbon monoxide levels in parts of the motel were eight times the acceptable level"
NE	Lincoln	12/30/04											10 y/o girls sick at pool party in afternoon, taken to hospital; hotel evacuated; prior incident on 12/25 family of 4 sick in pool area with vomiting and headaches, complained to hotel staff and were told "their sickness likely was caused by going between the hot tub and the swimming pool"; following incident hotel installed CO detectors in the pool area
LA	Baton Rouge	7/7/2004											listed on Dr. Weaver's spreadsheet, source listed as Advocate - unable to find information online
OH	Sandusky	7/7/2004											*listed on Dr. Weaver's spreadsheet, source listed as Blade (Toledo) - unable to find information online
VA	Richmond	7/7/2004											*listed on Dr. Weaver's spreadsheet, source listed as Richmond Times-Dispatch - unable to find information online
TX	Waco	7/7/2004											*listed on Dr. Weaver's spreadsheet, source listed as Waco Tribune-Herald - unable to find information online
MD	Ocean City	6/21/05											incident is referenced in a subsequent CO fatality at same hotel - see case # 2006-0627MD; "...several vacationers were taken to a nearby hospital and treated for exposure to carbon monoxide"; month and day of this incident is unconfirmed - one source lists "on or about June 21, 2005", another lists March 2005
NM	Ruidoso Downs	7/27/05											family taken by ambulance to the hospital where they were diagnosed with CO poisoning; CO leaked "from a poorly constructed or repaired exhaust venting system related to the Motel's pool heating equipment"

MT	Red Lodge	11/12/05	Michael & Jennifer Butler (8 months pregnant) - both injured; Laurie White (injured) - 5 months pregnant	Rock Creek Resort				42	pool and spa heaters	basement	2000 guests attending a Marine Corps banquet, sick throughout day. 42 required transport to hospital - 14 of them had to be flown to Billings for treatment ("at Billings Clinic, three people had to take turns in the state's only hyperbaric chamber"); victim Laurie White who was 5 months pregnant at the time of the incident gave birth prematurely a month later - the baby died two months later, premature birth was attributed to carbon monoxide poisoning; subsequent investigation by state inspectors listed "inoperable vents for the pool heaters, holes in the supply duct and other pieces of the system that did not appear to be working...new spa heater had apparently been installed in August without a mechanical permit"
NJ	Clinton Town	12/16/05		Holiday Inn	Y		14	generator	lower level	CO alarms went off in 2 guest rooms, 1 of which was occupied; "Members of the Clinton fire and police departments were the first to respond. At about 1am the Clinton Fire Department asked for assistance because of the high carbon monoxide readings. They conducted the necessary evacuation and it went great," said Sacco (hotel manager). "They helped provide optimal safety for the guests. It was very orderly." Hotel operations returned to normal about three hours later, Sacco said. Also responding to the scene were the Hunterdon County Office of Emergency Management and 16 area emergency services units. The county Office of Emergency Management sent its mobile command unit and set up a command center in a parking lot near the main lobby of the hotel, said Frank Venezia, county EMS deputy coordinator. Members of the Clinton and Quakertown fire departments checked each of the hotel's rooms with monitoring equipment...The Quakertown Fire Dept brought a large ventilator system that removed much of the carbon monoxide...by the time the Clinton squad arrived, Clinton Fire Chief Tim Langston was already checking rooms throughout the hotel...members of the Clinton Rescue Squad screened 115 people in one of the hotel's ballrooms...because of the large number of ambulances responding, a staging area was set up for incoming ambulances at the Commerce Bank parking lot. "We treated everyone from young to old, anyone on the floors of the affected areas," said Chad Newsome of the Clinton Rescue Squad. "The evacuation went well, the county got the command center set up quickly. We were very lucky. It could have been a lot worse."	
IA	Des Moines	2/13/06		Sheraton Hotel	Y		5			injured were all employees of hotel	
FL	Daytona Beach	3/12/06		Plaza Ocean Club Hotel			7			two guests taken to the hospital and diagnosed with CO poisoning; firefighters found elevated levels of CO on top two floors of the 11-story building; victims included two hotel employees; source determined to be a "leaky chimney pipe"	
IN	Mishawaka	4/8/06		Country Inn & Suites	Y		22	20 injured		Hotel manager called 911 when two children collapsed in the dining room; Fire Dept responded and found CO levels measuring 450ppm in pool room next to dining area; most of the injured were children ages 4-14 y/o; hotel was evacuated and closed until source of leak could be found	
NV	Yerington	4/16/06	Phillip Doll, 26, Donna Vega-Robles, 30, Juan Pablo Chavez, 27, & wife Veronica Espinoza Chavez, 20 (all deceased)	Casino West Motel			4	pool heater	below victims' room	victims checked into hotel at 5:30am and were discovered about 1:15pm after hotel maintenance worker answered complaint of water leaking into room below - went upstairs and found a female victim in bathtub with water running and male victim against bathroom door, high levels of CO found in surrounding rooms; "a series of problems led to the CO exposure"; "The heater used to warm the motel pool was not burning properly, a roof vent was not the proper height and the cap on the vent had been removed, the vents in the door to the pool equipment room had been covered with cardboard and sealed with duct tape, and the control panel had been altered such that there was no reasonable way to shut the heating unit off without disarming the power."	
MD	Ocean City	6/27/06	Patrick Boughter, 40 (deceased) & wife Yvonne Boughter, 36 (injured) & daughters Kelly Boughter, 10 (deceased) and Morgan Boughter, 7 (injured); Betty Jo Kennell & daughters Jennifer Hagenbuch and Michelle Robertson, & granddaughter Ashley Hagenbuch, 17, and Holly Brelsford, 17	Days Inn	Y		7	1 deceased 3 injured	basement - directly below victims' room	Multiple calls to 911 from victim Yvonne Boughter who reported she and her family were ill and confused, and from additional victims in neighboring two rooms - miscommunication between responders and dispatchers resulted in medics responding to other two rooms and not the Boughters. In addition, assumption was made that victims were suffering from food poisoning. Medics finally responded to Boughters' room 4 hours later when Yvonne came to and called 911 again, at which time both her husband and her older daughter were deceased; exhaust pipe leading from hot water heater to a vent to the outside became dislodged allowing CO to seep into 1st floor hotel rooms; boiler inspector found run of vent pipe was "way too long...which could have contributed to pipe supports collapsing and the pipe detaching"; water heater listed by manufacturer for residential use only and was not to be used in basements or under floor spaces, and it was listed as "for methane use only" but found to be running on propane; water heater was cause of a previous CO incident at this hotel on June, 21, 2005 where hotel "experienced similar problems with a hot water heater...several vacationers were taken to a nearby hospital and treated for exposure to carbon monoxide"	
WA	Fife	7/23/06		Emerald Queen Hotel & Casino			2			CO detected on third floor of hotel; fire dept contacted when hotel workers smelled a "chemical" odor coming from a storage room; evacuated third and fourth floors	

VA	Falmouth	7/27/06			Wingate Inn				7		boiler	first floor	911 received hang-up call from hotel, when dispatcher called front desk back hotel clerk said guests were complaining of dizziness and lightheadedness; rescue workers evacuated hotel; CO levels at 265 ppm ; highest concentrations of CO found in rooms above boiler
FL	Miami Beach	10/22/06		Y	Hilton			2					fire dept called when 2 guests began feeling ill; several guests tested positive for CO; building shut down for at least 3 days
FL	Key West	12/21/06	David Smith (injured) & wife Jody Smith (injured) & son Nathan Smith (injured)	Y	Doubletree Grand Key Resort			2		boiler			victims diagnosed with CO poisoning at hospital - see case below # 2006-1227FL
FL	Key West	12/27/06	Thomas Lueders, 26 (deceased) & father Richard Lueders, 53 (injured);	Y	Doubletree Grand Key Resort		1	7		boiler	adjacent to room of decedent		Hotel manager found victims unconscious in their room after a fire alarm went off, son was on bed and father was on bathroom floor - attempted CPR and also fell ill, all three were rushed to hospital; Thomas Lueders was pronounced dead on arrival to hospital, Richard Lueders was flown to Ft Myers for treatment in hyperbaric chamber; six days before this incident, on 12/21, a family from Iowa staying on same floor called for an ambulance - presumed cause was food poisoning so no investigation - hospital diagnosed CO poisoning and later stated they "did not notify the Doubletree hotel of the carbon monoxide exposure. Police rescue and fire personnel were also aware of the events"; Fire Chief said that family "rode in a boat and did other activities that could have exposed them to carbon monoxide before they fell ill". CO leak resulted from "the leaky, fourth-floor boilers and ill-repaired ventilation system on the roof"
MD	Baltimore	1/11/07		Y	Holiday Inn BWI			2		furnace	damper on rooftop furnace		CO alarm activated around 9am; hotel evacuated; Fire Dept. measured CO levels at 10ppm in lobby; "a damper on a rooftop furnace malfunctioned, drawing the exhaust back into the building, where it was recirculated"; victims hospitalized, both were employees - front office manager and line cook
PA	State College	8/7/07		Y	Residence Inn by Marriott			6					police and emergency personnel called to hotel for report of "high levels of carbon monoxide in the pool area"; hotel evacuated and six people taken to the hospital
PA	Upper Merion	9/3/07			MainStay Suites			4	3 injured	heater			3 children - ages 6, 5, and 3 - and a maintenance worker became dizzy in the pool area of the hotel, children were taken to emergency room where they were diagnosed with CO poisoning; diagnosing physician called the hotel to inform them to check for "carbon monoxide issues"; Fire Dept found high levels of CO in hotel and evacuated it; "found the heater was leaking gas" as well as a "faulty chimney"
CA	San Diego	11/9/07		Y	Marriott Residence Inn			2		water heater			housekeeper discovered victims unconscious in their beds at 2pm - they were supposed to have checked out that morning; Fire Dept responded and evacuated building; "it appears that a water heater vent pipe had come loose and filled their room with carbon monoxide"
AZ	Kingman	12/17/07			El Trovatore Motel			4					fire dept responded to a call for a "disoriented fall victim" about 8:30am and transported victim to hospital - about two hours later ER doctor contacted fire dept to inform them victim had CO poisoning and husband was still at motel; fire dept responded and evacuated a portion of motel; two other victims transported themselves to ER - article states reporter unable to determine total number of victims as hospital unable to disclose information due to confidentiality concerns; victims were extended-stay guests of motel; owner of motel "had given all tenants electric heaters, however some tried to supplement by turning on gas stoves and ovens overnight without proper ventilation"; CO levels measured at 80-110ppm
PA	Allentown	1/18/08	Phillip Prechtel, 63 (deceased) & wife Katherine Prechtel, 63 (injured), Jason Hannah (injured)	Y	Best Western Allentown Inn & Suites		1	9		water heaters	Basement - propane water heaters vented to outside, construction workers erected tent like canopy over vent		guest called 911 was suffering "flu-type symptoms" and single ambulance responded; an hour and five minutes later 911 was called for two unconscious guests and "within 15 minutes a Level 1 Multi-Casualty Incident was declared to bring in additional ambulances"; hazmat team measured CO levels at 100ppm ; CO determined to be coming from propane heaters venting to the outside properly, but their exhaust vents had been covered with a clear plastic tent to allow construction workers to repair stucco on the building's exterior; Fire Commissioner press conference: "Two police officers and three ambulance attendants who were first to arrive also were sickened...emergency personnel described a chaotic scene as they entered...while the fire alarm sounded and guests were evacuated, a woman lay on the floor of the lobby. Her skin was blue and she was barely breathing. She was being attended to by other hotel guests. The man she was staying with in Room 115 (her husband) was already dead. High levels of CO infiltrated the basement and first floor of the three-story hotel...there were no carbon monoxide detectors in the building"; the canopy erected by construction workers "trapped gases emitted by three 80-gallon, gas-powered hot water heaters" - CO levels measured more than 400ppm in the Prechtels' room; following the incident, hotel installed CO alarms in all guest rooms, Martin Plastering was
KY	Jeffersontown	1/20/08		Y	Comfort Suites			17		water heater			guests complained of headaches, shortness of breath, nausea and vomiting; CO readings on second floor of hotel at 440+ ppm ; water heater broken and serviced the day before the incident

MD	Baltimore	2/2/08	Luis Portillo, Sascha Schwieman (both injured)	Pier 5 Hotel Inner Harbor				20	boiler	basement	employees began feeling ill and vomiting, called 911 - Fire Dept. responded and evacuated hotel restaurant and lobby; CO levels measure at 700ppm ; victims were all employees of Ruth's Chris Steak House Restaurant which was housed in the hotel; subsequent investigation found CO leaking from crack in basement boiler and that it had been emitting CO "for a period of weeks"
NC	Raleigh	3/25/08		Subject #	Y		8		water heater	laundry room	five hotel guests in a vehicle flagged down an ambulance at 4:30am complaining of feeling sick; hotel was evacuated and three more guests were taken to hospital; "investigators found a heavy concentration of carbon monoxide in the laundry room"
TX	San Antonio	6/22/08		Hotel Mimosa Riverwalk			2	1 injured			hotel evacuated after a guest complained of nausea and a headache and CO leak was detected; a woman and her toddler were among the injured guests
VA	Virginia Beach	7/6/08		Ocean Sands Hotel			8				Fire Dept responded after receiving calls of about guests suffering from nausea; "Crews discovered an electrical short in a spa motor had caused a ventilation fan to malfunction. The fan didn't push the carbon monoxide out of the equipment area."
NY	Sweden	9/13/08		Holiday Inn Express	Y		2		water heaters		hotel's manager pulled the fire alarm when she began to feel ill and thought she smelled gas; 73 guests evacuated; CO levels measured at 1400 ppm
IA	Fort Dodge	1/31/09		Travel Inn			5	5 injured	furnace		five children became "lethargic and dizzy" in pool and were taken to the hospital; Fire Dept responded and found levels of CO "more than 14 times high than the safe level"
NC	Huntersville	3/23/09		Country Inn & Suites	Y		2				teenagers became ill - one lost consciousness - in pool area while attending a pool party
WI	Green Bay	5/7/09		Days Inn	Y		2		furnace		two guests called for ambulance thinking they had food poisoning, first responders suspected CO; firefighters pulled fire alarm to evacuate building; CO spread throughout ventilation system; officials detected levels of 800ppm on fourth floor where victims were staying; 1000ppm on the top floor - 5-story hotel; hotel windows do not open, difficult to ventilate building, leak traced to a crack in furnace
MD	Ocean City	6/11/09		El Capitan			6	2 injured	pool heater	basement	Fire Dept called when a family became ill - family included mother and father, two children and two grandparents; family was staying on the first floor; investigators detected levels of CO at more than 1000ppm , evacuated building and performed a door-to-door search on each of eight floors; subsequent investigation determined the pool heater was "improperly vented"; hotel had no CO alarms and was subsequently fined \$2000 by the fire marshal's office due to being out of compliance with a 2007 local law that was passed requiring them in all hotels in Ocean City, law was enacted as a result of 2006 case - see case #2006-0627MD
MD	Ocean City	8/11/09		Americana Hotel			3		see incident detail		police received call about guests being ill in hotel at approximately 8:20am, high levels of CO found throughout building, especially high in top three floors; police closed and evacuated hotel - firefighters conducted door to door search of 94-room seven-story hotel; 91 of 94 rooms were occupied; some parents were separated from their children when evacuation began; guests reported feeling ill the previous evening in their rooms; hotel owner subsequently pled guilty to failure to provide CO detectors, which were required in all hotels by a 2007 law passed following the 2006 deaths of a father and daughter (see case #2006-0627MD); owner also agreed to donate \$10,000 to the Ocean City Fire Dept to help with its CO detector outreach program; cause of CO leak was never determined, fire marshal quoted one year later: "Everyone had their theory, but with several mechanical devices in bad repair at the time, we may never know the real cause."
MA	Boston	9/16/09		Liberty Hotel					boiler		CO alarms sounded and guests were evacuated; "Investigators tracked the problem to a boiler that had a small hole."
NJ	Budd Lake	10/22/09		Marmot Residence Inn	Y				boiler		hotel manager called Fire Dept around 7:40am after an alarm activation in the boiler room; Fire Dept detected "elevated levels" of CO; partial evacuation
WV	Triadelphia	12/6/09	Christopher E. and Judith E. Groff, Ivan and Christine Liggett (injured)	Comfort Inn	Y		4		portable heaters used by construction workers		"construction workers employed retaining sheets and torpedo heaters to facilitate the work performed in the cold weather...caused buildup and release of carbon monoxide into guest rooms"
MI	Romulus	12/28/09		Best Western	Y		2				numerous guests ill - some passed out on hotel room floors, complained to staff; Fire Dept responded and evacuated hotel
LA	New Orleans	1/18/10		Ritz-Carlton			2				"buildup of carbon monoxide on some of the guestroom floors, which resulted in the evacuation of hotel guests and the treatment of some guests at nearby hospitals"
FL	Daytona Beach	2/13/10	Kenneth Shaw & wife Dawn Shaw (both injured)	Boardwalk Inn & Suites			2		pool heaters	parking garage below room	Victims' room was located on the first floor, directly above an enclosed parking garage; according to expert opinion in subsequent lawsuit, "brick grates originally designed to permit airflow into the garage for ventilation purposes had been blocked...allowed carbon monoxide to concentrate and enter the room through openings where plumbing lines penetrate the ceiling of the garage"

TN	Chattanooga	2/14/10				Y	Courtyard by Marriott		4		undetermined - possible delivery truck left running	hotel evacuated after 4 employees fell ill in break room in basement complaining of nausea and dizziness, one of the victims was reportedly pregnant; seven-story hotel, 120 of 128 rooms were occupied; CO may have entered hotel thru dryer vents from a delivery truck that had been left running a short distance away
NH	Portsmouth	2/15/10			Y	Hilton Garden Inn		12	3+	injured	boiler	Basement 911 called after a worker who was found unresponsive in the basement laundry room; CO detected and hotel was evacuated; CO was measured at 600 ppm, upper floors 100 ppm; source determined to be "a malfunctioning vent in the building's heating system, located in the basement"; "unsafe levels" of CO found throughout building; injured guests included "a number of children" who were in the pool; Fire Chief "determined there to be a Level 1 mass casualty incident" calling in ambulances from five neighboring areas; Fire Dept's "portable pulse oximeter allowed firefighters to evaluate guests and workers who might have been exposed, an estimated 25-30 people, and to determine whether they needed to be brought to the hospital"; hotel installed plug-in CO detectors immediately following incident but were required to install a hard-wired system in order to comply with a new state law that mandates CO detectors in hotels
NV	Reno	3/21/10				Keno Motel		5			boiler	basement "A metal exhaust flue that runs from the basement boiler and extends through the roof apparently was shaken loose by high winds"; CO measured at 240ppm; about 25 people live at the motel; fire dept called when several guests began feeling ill
NY	Melville	6/28/10			Y	Melville Marriott	Steven Anderson (injured)				water heater	below victim's room two guests ill and went to hospital where they were diagnosed with CO poisoning - hospital alerted hotel who called Fire Dept; Fire Dept found elevated levels of CO in guest rooms above the boiler room; another victim reported feeling nauseous during the previous night, for period of time was unconscious on bathroom floor, awakened around 4:30pm by firefighters evacuating the building, subsequently collapsed in hallway and was taken to the hospital
IA	Mt. Vernon	11/11/10			Y	Sleep Inn		3			boiler	Firefighters called to hotel for sick guests, found "exhaust pipe for a water boiler came loose, causing carbon monoxide to escape into the building"
WV	Snowshoe	12/26/10				Seneca Lodge - Snowshoe Mountain Resort		5			water heater	Fire Dept responded to call for person with chest pain and found another person with similar symptoms - determined CO was present and evacuated building; victims were all employees, 2 unresponsive when evacuated; CO levels on ground floor measured 999 ppm as high as monitors would go
FL	Hialeah	12/27/10				Hotel Presidente	Juchen C. Marcial, 19, Peterson Nazon, 17, Jonas Antenor, 18, Jean Pierre Ferdinand, 16, Evans Charles, 19 (all deceased)	5	3	deceased	car exhaust	victims parked in the bottom-floor, single car garage and left car running due to low battery the door to the interior stairway leading the room on the second floor was opened slightly, allowing the CO to seep upstairs; maid discovered the victims and called 911
CA	San Francisco	1/6/11			Y	San Francisco Marriott Marquis		6			water heater	victims were 4 guests staying in 4 separate rooms - in evening all complained of flu-like symptoms and contacted hotel doctor who recognized "there was a safety issue," hotel staff called Fire Dept who responded and found high levels of CO; two days before incident 2 separate ambulance calls had been placed for for sick guests in same rooms but connection to CO not made; investigation led to discovery of CO leaking from a water heater in a restaurant next to hotel and drawn into hotel's air intake system
ME	Portland	3/4/11			Y	Residence Inn		7				Fire Dept was notified when 2 guests went to hospital experiencing nausea and headaches, evacuated hotel; high levels of CO found in rooms and hallways, some 500ppm; Fire Chief said "...exhaust fumes from the heating system were sucked into the air intake system on the building's roof. The problem seems to have been caused by a combo temperature inversion and wind currents."
NY	West Seneca-Buffalo	3/12/11			Y	Hampton Inn		9			heater	"Police responded to a call from the front desk manager at about 5:30am yesterday after two guests asked to be moved to a new room. The couple felt dizzy and faint and had told hotel workers they believed fumes in their room were responsible." High levels of CO found on five floors of hotel; police and fire conducted room-by-room evacuation
UT	St. George	4/15/11			Y	Comfort Suites					water heaters	hotel called gas company for "complaints of what was believed to be carbon monoxide"; gas company found high levels of CO on first, second and third floors - called Fire Dept; hotel evacuated; "some exhaust piping had separated and caused CO2 (sic) to leak onto the floors"
MD	Laurel	4/30/11			Y	Sleep Inn		11	5	injured	pool heater	Fire Dept called to hotel for reports of five children complaining of headaches and nausea; discovered high levels of CO and evacuated hotel
AR	Little Rock	6/9/11			Y	Comfort Inn		10	2	injured	pool heater	family of 4 (2 adults and 2 children) taken to hospital; fire dept found unsafe CO levels on all floors
OR	Agate Beach	6/19/11			Y	Agate Beach Best Western		3	1	injured	dryer	2 employees ill in laundry room with upset stomach and dizziness, hotel called 911; Fire Dept responded with with 2 fire engines, 1 ladder truck, 1 heavy rescue vehicle and 17 firefighters; hotel evacuated and high levels of CO were detected in basement; upper floors 400-600ppm; 3 y/o girl transported to hospital

OK	Norman	7/25/11					Sooner Legends Inn & Suites		21		boiler		family staying at hotel took their 3 y/o to ER when he began having trouble walking and was acting intoxicated - nurse called alerted the fire dept that child may have inhaled some kind of gas; Fire Dept detected high levels of CO and evacuated building; CO found to be leaking from "a damaged ventilation pipe running from boiler to roof"; hotel owner said incident was a wake-up call and purchased CO detectors for entire building
PA	Allentown	7/25/11		Y		Best Western Allentown Inn & Suites					water heaters		2nd incident of CO at this hotel (prior incident - see case #2008-0118PA); according to hotel, a power surge caused water heaters to malfunction leading to gas leak; CO alarms (installed after 2008 fatality) went off and all guests were evacuated safely w/o illness or injury; hotel was closed for approximately one month before receiving a certificate of occupancy allowing reopening after leak
OH	Columbus	9/3/11		Y		Comfort Inn & Suites					water heater	mechanical room	Guest's portable CO alarm went off in room, registering levels of 20-25ppm; manager let him into an empty room which also displayed a high reading so called fire dept who discovered a malfunctioning water heater
IL	Bourbonnais	11/12/11		Y	9	Holiday Inn Express & Suites	Shawn & Jessica Hilborn & their three children; Christopher & Courtney Coombs & their 2 children		5	5 injured	pool heater		Guests experienced nausea, headaches and dizziness while at pool, children lost consciousness; Fire Dept arrived and determined high levels, exceeding 300ppm, of CO in swimming pool area
CT	Danbury	11/25/11			2	Ethan Allen Hotel					boiler		employees smelled what they thought was a gas leak near the kitchen area and contacted authorities who told them to evacuate the building; Fire Dept arrived and found high CO levels; source of leak was an "improperly vented water boiler"
WI	Green Bay	12/30/11		Y	16	Hilton Garden Inn					pool heater	mechanical room	911 called for 2 children who were sick in pool area around 9pm; when rescuers arrived, found "four small children and other victims suffering symptoms that included headache, nausea and vomiting"; more guests came forward complaining of similar symptoms; "reports show that ambulances transported a 17-year-old girl"; fire officials found CO levels at 800ppm near pool and 957ppm in adjacent equipment room, along with high levels in a workout room, a stairway and several restrooms; "The fire department also directed hotel employees to check out other guests throughout the 123-room hotel. Two staff members then took a list and proceeded to do a room-by-room search"; WI law required CO detectors at this time... possible issue at hotel not being in compliance
ND	Williston	1/29/12			12	Airport International Inn					boiler	pool area	guest collapsed in shower, phoned for help; ambulance arrived and called Fire Dept for assistance with hotel evacuation; many of hotel guests were parents and players of hockey team from Weyburn, Saskatchewan, Canada, who were in town for a tournament; parent whose son required oxygen treatment at hospital described the scene as "unorganized chaos...staff just continued working as if nothing had happened"; CO leak "blamed on an object being blown over a boiler vent in the hotel's pool area"; CO alarms installed following incident
WV	South Charleston	1/31/12		Y	1	Holiday Inn Express	William Moran, 44 (deceased), Isaac Croy, Emmett Williams, Craig Reed, Terry Harvey, Dale & Susan Rosenbrook, Bain Edmondson (all injured)		16	24+ injured	pool heater		victims Moran and Edmondson were discovered deceased and unconscious; seizing, respectively, in room 511 by two co-workers who had been let into room by hotel manager when they failed to show for a morning meeting - called 911; on arrival, Fire Dept rendered aid and with police questioned co-workers about victims' previous activities, transported surviving victim to hospital and immediately began testing for CO and got reading of 317ppm in room; evacuated and called for additional units to do room-to-room search; found heaviest CO concentration on 3rd-5th floors ranging from 200-750ppm; Fire Dept Investigation Summary 2/12/2012: "Upon completing interviews and a thorough investigation, it has been concluded that the vent flu pipe was physically manipulated at the top to be connected to the outside vent. This was likely done when the unit was originally installed approximately 11 years ago. The removal and inspection of the old pool heater unit started the process of the vent flu pipe coming loose. The installation of the new pool heater unit further compromised the pipe. There were scratches on the piping indicating that it had been moved along the hole between floors against the concrete. Through vibration of the water filtration system and the pool heater unit, the vent flu pipe became dislodged thus creating a buildup of carbon monoxide in the open shaft area. The heat from the pool heater traveled through the vent pipe forcing the carbon monoxide to travel to rooms on both sides of the shaft and into the elevator shaft. In room 511, the heater ac unit was set to fan only so the movement of air was limited to the room. After installation of the new pool heater, there were no procedures followed as recommended by the manufacturer of that particular unit. The unit was therefore not properly tested and inspected. There were no work records obtained prior to conclusion of the work performed. The City of South
TX	Irving	3/19/12		Y	5	Hyatt Place	Man, pregnant woman and their three children, ages 1, 8 and 10 (all injured)			3 injured	boiler		family of five staying at hotel drove themselves to hospital due to headaches and nausea - staff at hospital diagnosed CO poisoning and contacted fire dept who responded and evacuated hotel after finding CO levels at "more than 100ppm"; multiple guests experiencing nausea, headaches and disorientation
MD	Elkridge	8/27/12		Y		Holiday Inn Express					heater		hotel evacuated after high levels of CO detected
VT	Burlington	10/24/12		Y		Courtyard by Marriott							hotel evacuated "after carbon monoxide detectors signaled Burlington fire department at 7:53am"; "highest levels were on the east end of the third and fourth floors, reaching 70ppm"; hotel full with approximately 180 guests - no injuries reported; fire marshal determined "problem was apparently caused by a 'thermal inversion' - a cold, foggy air outside the hotel inhibiting the expulsion of exhaust"

CA	Burlingame	11/7/12	Robert McNamara, 58 (injured)	Embassy Suites Hotel	Y	1	boiler	pool equipment room - below victim's room	<p>victim checked into hotel on 11/6 and when he failed to show up for a meeting on 11/7, coworkers discovered him unconscious in his room with blood and vomit coming from his nose and mouth and called 911; he was taken by ambulance to the hospital around 6:30pm - CO was suspected by ER doctor but test results were "contradictory"; medic who transported victim later returned to the hospital on an unrelated ambulance run and encountered ER physician who relayed suspicion of CO poisoning - medic reported concern to fire dept around 12:10am; fire dept went to hotel and found CO levels ranging from 20-90ppm on all nine floors - victim's room measured 90ppm; "Workers at the front desk began calling rooms. Of five called, only one responded. Concerned for the safety of the guests, authorities pulled the fire alarm and evacuated hundreds of people"; San Mateo County District Attorney's Office sued hotel alleging that "the hotel installed a boiler in a pool equipment room in 1996 without obtaining a permit from the city as a cost-saving measure. Over the next 14 years, the hotel did not properly maintain the equipment and it became clogged, holes opened in ventilation pipes and the room's configuration was changed, which prevented proper ventilation and caused a significant carbon monoxide leak." According to a news article, "A state law requiring carbon monoxide detectors in most multiunit dwellings in California went into effect Jan 1. It was also supposed to apply to hotels and motels, but California Hotel & Lodging Association obtained a three-year extension." State law requiring alarms in hotels and motels would not go into effect until 3 years later, 2016; according to subsequent lawsuit, victim spent three months in the hospital with severe brain damage</p> <p>desk clerk called 911 when group of children and adults attending party at hotel reported having severe headaches and nausea; hotel evacuated, high levels of CO found in lobby and pool area related to "a water heater failing to vent properly"</p> <p>ambulance called for 54 y/o man experiencing rapid heart rate and dizziness, 2 hours later another ambulance call for a 54 y/o man experiencing similar symptoms - emt contacted gas company, responded with police and fire who evacuated hotel; found another guest unconscious in room; "portions of the pipes connected to the heater were rusted, eroded, and deteriorating"</p> <p>several 911 calls placed reporting an "unusual odor of gas"; hotel was evacuated, firefighters measured levels of carbon monoxide on several floors of the six-story hotel at 50ppm; "faulty" natural gas heater found on roof that supplied heat to common areas of hotel</p> <p>hotel evacuated when CO detected</p> <p>2 guests called EMS complaining of flu-like symptoms - firefighters noticed the guest room's proximity to the boiler room and checked CO levels - boiler room was 2000ppm, lobby 300ppm; cause determined to be a broken exhaust fan in boiler room; another guest staying in the room was hospitalized 4 days prior for similar symptoms "but no one made the connection to carbon monoxide exposure, and the guest was not tested."</p> <p>hotel manager called 911 after a "strange odor" was noted on upper floors; Fire Dept evacuated hotel after CO levels discovered to be "over 200ppm"</p> <p>Fire Dept called for possible gas leak, found high levels of CO in basement and lobby, low levels in alley behind building</p> <p>2 housekeeping staff ill with nausea, dizziness and vomiting in basement laundry room, 911 called; Fire Dept found high levels of CO and evacuated building</p> <p>family called 911 after unable to wake one of their family members - woman conscious when rescue workers arrived but rest of family, including at least one child, were all experiencing "flu-like" symptoms; firefighters found elevated CO levels in all rooms on 5th & 6th floors and ordered evacuation; reports of guests with similar symptoms earlier in the week, including a family who had checked out and returned home to Florida - Fire Dept contacted them so they could seek treatment; cause of leak found to be a "malfunction in a vent system that vented the hotel's pool heater"</p> <p>On second morning of their stay, victims awoke in their room feeling dizzy and nauseous and one collapsed - 911 called; fire dept responded and found "elevated levels" of CO in room; victims transported to hospital; previous occupant of room reportedly had been ill as well and reported symptoms to hotel staff</p> <p>no media story until after death of another person in same room 5 weeks later (see case # 2013-0608NC); victims discovered in their room by maid when they failed to show up to meet traveling companions for breakfast in lobby, man deceased in jacuzzi tub and woman unconscious on floor - declared dead on arrival to emergency room; pool heater broken/"serviced" 4 days prior to deaths (detail listed in subsequent case)</p> <p>victims included 10 teenage girls attending a pool party and staying overnight in room 325 (see case # 2013-0416NC above, two victims had died of CO poisoning in room 225 but cause of death was not known at the time of this incident. cause of death not determined until death of a third victim in room 225; see case # 2013-0608, at which time this incident was then publicized); after spending time in pool and lobby area, victims went to room and began feeling ill, experiencing headaches and nausea; all but one girl went home ill, and remaining occupants of room slept with the window open, notified front desk "several times" that they were all ill</p>
KS	Greensburg	12/9/12		Best Western Plus Night Watchman Inn & Suites	Y	3+	pool heater	mechanical room	
AR	Siloam Springs	1/21/13	James Fick (injured)	Hampton Inn	Y	5	pool heater		
VA	Virginia Beach	2/6/13		Homewood Suites	Y		heater	roof	
KS	Meriam	2/24/13		Drury Inn	Y				
FL	Fort Myers	2/25/13		Crestwood Suites		2	boiler	boiler room	
KY	Lexington	3/6/13		Homewood Suites	Y				
VA	Norfolk	3/11/13		Tazewell Hotel & Suites			water heater	basement	
TN	Chattanooga	3/19/13		Hixson Holiday Inn Express	Y	2			
AL	Hoover	3/29/13		Renaissance Ross Bridge Golf and Resort		15	pool heater	basement	
GA	College Park	3/31/13	Laveda Green, Jamey Green, Courtney Green, Marilyn Burnett	Wyndham Garden Hotel	Y	4			
NC	Boone	4/16/13	Daryl Jenkins, 73, (deceased) & wife Shirley Jenkins, 72 (deceased)	Best Western Blue Ridge Plaza	Y	2	pool heater	below victims' room	
NC	Boone	4/19/13		Best Western Blue Ridge Plaza	Y		pool heater	two floors below victims' room/adjacent to pool	

MN	International Falls	5/6/13					Amniclim	Y	1	pool heater		victim found unresponsive in room (138), fire chief discovered two ambulance runs were made to the same room in a short time (April 29 and May 6); first thought illnesses were due to exposure from pool chemicals, hazmat team called and determined malfunction of pool boiler - all poolside rooms were evacuated, CO levels tested at 400-500 ppm; investigation discovered recently installed new boiler was not permitted and "size of the boiler was not proper"; other victims discovered who originally attributed symptoms to sickness and/or were moved to other rooms before symptoms advanced; following incident fire chief purchased detectors for the club's bar, bar, and other areas.
PA	Lancaster	5/10/13				Heritage Hotel			2	boiler		2 guests went to hospital experiencing "symptoms similar to carbon monoxide poisoning"; hotel was evacuated - firefighters found high levels of carbon monoxide on second and third floors
NV	Reno	5/11/13				El Cortez Hotel			12	water heaters		Hotel evacuated after guests began "feeling ill"; businesses on first floor of hotel also evacuated (subsequent incident at this hotel - see # 2013-0601NV)
WI	Oshkosh	5/13/13			Y	Hilton Garden Inn					mechanical/laundry equipment room	CO detector went off - first responders found high levels of CO and evacuated hotel; 19 firefighters and five ambulances responded to assist with evacuation and checking guests for CO exposure
NV	Reno	6/1/13				El Cortez Hotel			8	"appliances"		Fire Dept called after guest ill; discovered elevated CO levels in basement, hotel evacuated - second incident at this hotel (see case # 2013-0511NV)
NC	Boone	6/8/13			Y	Best Western Blue Ridge Plaza		1	1	pool heater	below victims' room	victims discovered by hotel staff when husband/father phoned front desk to ask that room be checked after victims failed to show to meet family - boy found deceased on bed, mother unconscious on bathroom floor, 911 called - fire department responded and measured CO at "lethal levels"; two deaths due to CO poisoning in same room (225) five weeks earlier (see case # 2013-0416NC) - carbon monoxide suspected as cause immediately following deaths, but investigators opted to wait for results of toxicology testing on victims to confirm - not confirmed until after this incident; guests also reportedly ill on 4/19/2013 in room 325, one floor up from room 225, two floors up from pool heater; subsequent investigation revealed the following: there were no CO alarms installed in the hotel (some staff erroneously thought the combustible gas detectors and/or the smoke alarms in the rooms were CO alarms); the pool heater was housed in same room as corrosive pool chemicals; pool heater had been previously used and then moved from another hotel w/o proper permit and installed by unlicensed hotel maintenance workers and subsequently converted to natural gas against manufacturer's instructions; pool heater reportedly not working in April and had been "serviced" by a repairman who was not commercially licensed; pool heater found to be venting thru a corroded exhaust system that
NJ	Carlstadt	6/13/13			Y	Holiday Inn Express			1	pool heater		Police and Fire responded to report of activated CO alarms at hotel and evacuated building; Carlstadt Office of Emergency Management also responded; CO levels measured at 300ppm; CO leak traced to pool heater "which recently had been repaired"; hotel staff member hospitalized; "The detectors are battery operated and not hardwired, so the staff at first thought they simply needed battery changes...after the batteries were replaced, the detectors activated again, so authorities were called"
WI	Lake Delton	6/14/13			Y	Travelodge			9	pool heater		hotel employees ill and noticed CO alarm "flashing"; Fire Dept. evacuated hotel; cause of leak determined to be "blocked heat exchangers" for 2 heaters in the indoor pool area; hotel management purchased "new and additional carbon monoxide detectors" following incident
CT	Glastonbury	10/29/13			Y	Homewood Suites				heating unit		Fire Dept responded and evacuated hotel when a CO alarm went off; "Traced the source to a heating unit and are ventilating it"
CA	Palm Springs	11/13/13				Curve Palm Springs Hotel & Resort		1	1	pool heater	below victim's room	victim discovered deceased on floor of his room by police after family had contacted them because he had not returned from his vacation; reports of guests ill in same room in weeks before victim checked in; CO exposure related to improperly vented pool heater
TX	San Antonio	12/8/13			Y	LaQuinta Inn and Suites					boiler room fifth floor	hotel evacuated after "two guests were reportedly exposed to carbon monoxide"; Fire Dept "found carbon monoxide had accumulated from the boiler room to the fifth floor of the building"
SD	Aberdeen	12/20/13			Y	Ramada Inn				water heater	basement	Fire Dept called - restaurant and bar evacuated
OH	Cleveland	12/28/13			Y	Wyndham Hotel			21	boiler		Fire Dept and gas company responded to a call for a CO leak at 9:30am; evacuated hotel and found high levels of CO; those injured ranged in age from 9 months - 66 years; including a woman who was 7 months pregnant; the previous evening a family called front desk to report a "strange smell" in their room and hallway... "to us, it smelled like natural gas, and that's what we told the front desk...later we were told an engineer had analyzed and identified the smell as a sewer odor that was said to not be toxic or hazardous...the next morning we woke up with headaches...a short time after that, the hotel was evacuated"

ID	Idaho Falls	1/27/2013	Jennifer Bright	Le Ritz Hotel & Suites					1		1	1	1	1	1	1	victim was employee of hotel; while at work she experienced symptoms of CO poisoning, including dizziness, nausea, fatigue and severe headaches for two months but was not told there had been a CO leak into her office until two years later, according to subsequent lawsuit "the maintenance from the pool in the hotel traveled above (victim's) office, carried toxic carbon monoxide gas from the pool pump and heater... had a leak over (victim's) office"			
TX	Lubbock	1/16/14	Harold Rutherford, 59 (deceased), Leltesha Renee Ruth, 43 (injured)	Budget Motel					1								wall heater	room		
ID	McCall	2/10/14		America's Best Value Inn													pool heater	1 injured		
TN	Pigeon Forge	2/14/14		Mountain Vista Inn and Suites													pool heater		2	
MD	Linthicum Heights	2/16/14	Merletha McKisset, 58 (injured)	Westin			Y										water heater	laundry room - first floor	9	
ME	Ogunquit	2/23/14		InnSeason Resorts - The Falls													furnace	basement	21	
KY	Jeffersonton	3/16/14		Fairfield Inn & Suites			Y													
NC	Greenville	3/18/14		Home-Towne Suites																
MD	Cumberland	4/22/14		Ramada Inn			Y										gas appliances	kitchen		
PA	Crescentville	7/4/14		Days Inn			Y										generator	basement	5	
PA	Dunmore	8/24/14	Julie & Keith Nutt (both injured)	Best Western Plus Hotel on Tigue Street			Y										pool heater		30	
VA	Chantilly	9/17/14	Max Kipfer, 57 (injured)	Hampton Inn Dulles Airport South			Y										boiler		1	
WA	SeaTac	11/1/14		Radisson Hotel			Y										pool heater			
NC	Charlotte	11/3/14		Sleep Inn			Y										"improper equipment"	4th floor		
IL	Naperville	11/10/14		Hotel Arista													HVAC unit	roof		
AR	Rogers	11/11/14		Candlewood Suites			Y										pool heater			
ID	Preston	11/15/14		Riverdale Resort													portable heater		19	
PA	Concordville	11/18/14		Best Western Plus Concordville Hotel			Y										heater			

FL	Orlando	1/18/15	Zachary Williams	Staybridge Suites															victim at hotel with family and began to "feel sick", weakness in his legs, rapid heartbeat, drowsiness and dizziness", diagnosed with CO poisoning
MD	Bismarck	1/18/15		Holiday Inn Express	Y					4 injured	boiler	adjacent to pool						paramedics responded to reports of children feeling ill and dizzy in pool area; victims were 4 children and 2 adults and 7 employees; hotel workers evacuated pool area prior to ambulance arrival; source of CO determined to be a boiler in room next to pool area	
ND	Bismarck	1/21/15		Holiday Inn Express	Y					6								second incident at this hotel in 3 days - "Fire Department responded to carbon monoxide alarms going off in the building's pool and boiler rooms"; shut off gas line and reported that hotel maintenance was "working on the problem"	
IL	Annawan	2/15/15		Best Western Annawan Inn	Y					4	pool heater							4 children ill in pool area; CO levels measured at 999ppm; CO detector in pool area did not have audible alarm	
IA	Council Bluffs	3/22/15	15 y/o boy and 37 y/o woman (injured)	Quality Inn & Suites	Y					4	boiler							Fire Dept called to hotel for report of "several people feeling nauseated in the pool area"; firefighters found CO levels of 600ppm in pool room and guest rooms; victims were members of hotel owner's family - swimming in pool when they got sick	
GA	Peachtree Corners	4/13/15		Hilton Atlanta Northeast	Y					7	"multiple sources"	boiler room						victims were employees who alerted fire dept they were feeling ill since early in the morning; hotel equipped with CO detectors (unclear whether they alarmed); hotel evacuated and guests relocated to other hotels after leak was determined to be coming from "multiple sources"	
WY	Gillette	6/3/15		Hampton Inn	Y													Gas Company notified fire dept who evacuated hotel after detecting "dangerous levels of carbon monoxide" on the third floor	
MA	Hyannis	7/9/15		International Inn							boilers	basement						Fire Dept "received a call from an alarm company about an activated carbon monoxide detector sounding in the basement"; on arrival Fire Dept detected high CO levels and pulled fire alarm to evacuate building; high CO levels of "well above 100ppm" throughout building; workman had been onsite in boiler room earlier in day	
NY	Holtsville	8/13/15		Ramada Plaza-Long Island														Fire Dept/police called to hotel for report of "high levels" of carbon monoxide; guests and employees were evacuated to parking lot when responders arrived; "A possible source being examined is a heating-air conditioning system"	
IA	Sioux City	9/2/15	30 y/o woman, her two children and her parents (injured)	Corey Motel - Extended Stay						5								rescuers called to hotel on report of five people with headaches and vomiting; unit's hot water heater had reportedly stopped working earlier in the day; "source of the toxic gas was not immediately known, but an initial investigation showed it may have come from obstructed exhaust from the water heater, stove or furnace"	
IN	Evansville	11/13/15		Holiday Inn Express	Y					1	water heater							employees smelled gas and called 911; hotel was fully booked for soccer tournament; Fire Dept reported natural gas leak as well as CO; "vents off water heater weren't working properly"; "The property was yellow-tagged, meaning no guest or employee was allowed inside until the repairs were made and the building commission gave the all clear"	
IL	Pontoon Beach	1/30/16		Super 8	Y					4								4 children at pool party and became ill - hotel called 911; Fire Dept discovered bird's nest clogging pipe from utility room, also discovered hotel's CO detectors were not plugged in; "Officials say the problem has been fixed and all gas levels are normal. The motel has even put an external cover on the pipe in the utility room which was clogged to make sure this does not happen again. It's been recommended that it also use a hardwired carbon monoxide detector in the future."	
OH	Delaware	2/6/16		Best Western Delaware Inn	Y						pool heater							"CO detectors in pool area and pool heater activated. Initial CO reading was 114. Gas line to pool and hot tub heaters turned off in heater room. Windows opened in pool room and area ventilated, CO reading dropped to 74. Hotel rooms above and alongside of pool checked for CO with no readings noted. Hotel clerk advised to keep pool and hot tub heaters off until they could be serviced."	
IN	Huntington	2/13/16		Quality Inn	Y					20	pool heater							investigation discovered "extension pipe between the indoor water heater and outdoor exhaust vent was rusted and had fallen apart" - maintenance worker had reportedly been working on the exhaust system earlier that day	
OH	Austintown	3/11/16		Sleep Inn	Y					18	pool heater							EMS called to hotel for child who had fallen in pool area - responders carry CO alarms on their EMS bags, which began alarming; CO levels at 600ppm; high levels in pool area and upper levels of hotel; Fire Chief reported "the biggest struggle was getting everyone out...we set the fire alarms off and people just ignored them"	
MO	Sunset Hills	4/8/16		Hampton Inn	Y													gas company, fire and police responded to report of gas leak at hotel in pool area, evacuated hotel	
NY	Queensbury	4/20/16		Six Flags Great Escape Lodge							boiler	basement						hotel evacuated when CO alarm went off; Fire Dept found "slightly elevated" levels of CO in the basement; "an issue with a boiler intake was found and repaired"	
NY	Queensbury	4/21/16		Six Flags Great Escape Lodge														2nd incident of CO at this hotel, 1st on 4/21/2016 - hotel evacuated when CO alarm went off	
ME	Portland	6/6/16		Howard Johnson	Y					1	furnace	below victim's room						EMS called for ill guest; rescue crews found a man "unconscious and vomiting in a stairwell"; CO alarms on EMS bags alerted to high levels of CO; CO levels of 400ppm - highest level was found in room of ill guest, located above the "furnace room"; hotel reportedly equipped with CO detectors but unclear whether they alarmed	

MI	Warren	7/25/16								Hawthorn Suites by Wyndham	Y						2	boiler	A couple and their dog were found unconscious in their room by hotel housekeeper; CO levels at 439 ppm were detected; cause of CO reportedly associated with boiler and "melled pipes and wires"; quote from fire commissioner: victims "reportedly checked out at 11:30am and went found when an employee later went to clean the room...the husband went down and checked out...went back up to the room to get his wife. For whatever reason, we don't know if he became disoriented; he decided to lay down also. If he hadn't checked out, and the maid hadn't gone to his room, we would have been looking at a tragedy."
NC	Morganton	8/17/16								Comfort Inn	Y								"a hot water heater caused a sprinkler to go off in a room that houses the hotel's electrical equipment" - first responders detected "high levels" of CO on every floor and evacuated building
MA	Andover	8/26/16								LaQuinta Inn and Suites	Y								CO alarm sounded; Fire Dept responded and evacuated hotel; CO levels measured at over 100ppm in laundry room; "Columbia Gas has determined what appliance caused the high levels of CO to be emitted and have subsequently shut them down. The gas inspector is on scene to determine how to best replace the problematic units."
NJ	Bridgewater	9/8/16								Days Inn	Y								hotel evacuated after CO alarm sounded; "hotel employees went door-to-door to make sure all of the rooms were cleared"; 1 firefighter hospitalized due to CO; "firefighters discovered that water heaters were to blame for the elevated CO. PSEG was called in to cap the heaters"; hotel was issued a violation
MA	Springfield	10/18/16								Marmott Hotel	Y								two floors evacuated after "unsafe" levels of CO related to a malfunctioning boiler; approximately 50 guests evacuated from sixth and seventh floors; CO levels measure at 3000 ppm on both floors
DE	Dover	11/5/16								Home2 Suites by Hilton	Y								Fire Dept responded to a CO alarm, found elevated CO levels on 4th floor - pulled fire alarm to evacuate hotel; on further investigation found "dangerously high levels in the pool heater room"; another leak found in utility area at opposite end of building
CO	Durango	12/20/16								Residence Inn	Y								Fire Dept responded and evacuated hotel; 2 boys who had been playing in pool area were hospitalized for CO poisoning; some hotel staff experiencing headaches; source of CO determined to be pool boiler; "the owners intend to replace the entire boiler unit"; "They did have carbon monoxide detectors throughout the hotel, but unfortunately, the one in the pool area was defective"
NC	Ashville	12/23/16								Clanton Inn	Y								Fire Dept called to hotel at 2:15am for high levels of CO, evacuated building; CO caused by hotel staff using gas powered pressure washers outside building - the HVAC system sucked the carbon monoxide into the building"
WI	Lake Delton	12/28/16								Sunset Bay Resort									CO alarm went off and guests evacuated without incident; "Fire officials said the incident is a good reminder to businesses and homeowners to install and regularly test CO detectors in any place where there are gas fired appliances."
NY	Plattsburgh	1/7/17								Comfort Inn & Suites	Y								hotel CO alarm sounded about 4:00am and firefighters responded to hotel; found CO source to be malfunction of a heating unit in restaurant next door; the hotel's five rooms in the area of the restaurant were evacuated to lobby of hotel while firefighters investigated
TX	Corpus Christi	1/10/17								Omni Hotel									victims were hotel staff who complained of lightheadedness and nausea; Fire Dept called and victims were transported to hospital; hotel was evacuated; high levels of CO found on lower floors; "Smaller levels of gas were detected on some of the hotel's higher floors, following the path of the elevator shafts"
MD	Clear Spring	3/2/17								Sleep Inn & Suites	Y								Ambulance crew called to assist a guest with a medical condition; their personal CO detectors alarmed alerting them to a CO leak that was subsequently traced to a propane pool heater
MA	Mansfield	3/27/17								Holiday Inn	Y								hotel evacuated and fire dept called when CO alarms went off around 6pm; CO levels measured at 800ppm on first floor; high CO levels detected in a mechanical room and on the first and second floors near and above the pool heater; "heaters for the pool and whirlpool were shut down and the cause is being investigated"
MI	Niles	4/1/17								Quality Inn & Suites	Y								a hotel employee discovered 6 children unconscious in pool area; EMS called and hotel was evacuated; 1 child found unconscious in a first floor room; CO levels measured at 800ppm ; additional victims were hotel staff and first responders; cause determined to be "a pool heater ventilation pipe disconnecting from the pool heater. This likely caused carbon monoxide to leak into an enclosed pool maintenance room. An exhaust system in the pool maintenance room vented out of the room and into the enclosed pool area."
MD	Baltimore	4/8/17								Marmott Delta Hotel	Y								Fire Dept called after CO leak detected in basement; hotel evacuated; two guests transported to hospital
MI	Novi	4/26/17								Novi Oaks Hotel									hotel worker ill and called 911; hotel was evacuated after Fire Dept detected high levels of CO; mechanical inspector determined "a pool heater had improper ventilation"
AR	Bentonville	5/1/17								Holiday Inn Express	Y								Fire Dept called after CO alarms went off at hotel around 8am; hotel evacuated; source of CO was listed as "construction related" - hotel is "being renovated and a construction crew was putting a roof on the building"

State	City	Date	Victims	Hotel	Y/N	Injured	Deaths	Notes
ND	Fargo	5/29/17		LaQuinta Inn and Suites	Y	2+	11	9 Y/O girl transported to hospital after getting sick in pool area. 10 other guests sought medical attention; Fire Dept responded and detected CO levels at 300ppm in pool area and hallways, cause not immediately apparent but pool heater suspected
VA	Warrenton	7/24/17		Holiday Inn	Y			hotel evacuated due to "very high levels" of CO; Fire Dept "said the source of the carbon monoxide has been narrowed down to gasoline powered equipment"
CA	Chico	7/27/17		Marront Residence Inn	Y		2	ambulance called for two guests experiencing headaches, dizziness and nausea - transported to hospital; hospital diagnosed CO poisoning and alerted fire dispatch; Fire Dept responded to hotel and evacuated remaining guests; CO levels in victims' room measured at 150ppm, in adjacent room that housed water heater levels measured 550ppm
TX	Perryton	8/24/17	Patricia, 58, (deceased) & husband David Ivie, 62 (deceased)	Best Western	Y		5	victims discovered unconscious in their room (217) by housekeeper when she heard CO alarm sounding in room - woman was on bed, man was on floor; hotel evacuated; Fire Dept found "substantial levels" of CO in parts of the hotel; firefighters discovered that guests in room located four doors down from room 221 had taken the battery-powered CO alarm off the wall and placed it on the nightstand with a note stating the alarm went off at 3:30am and 4:30am and said the battery needed replacing; Patricia Ivie died from her injuries two months later, and David Ivie died of his injuries four months later
NC	Fayetteville	11/7/17	Michael Brown (injured) & wife	Marront Residence Inn	Y		3	TWO GUESTS WERE UP NOTICING WEIR AND WENT TO THE HOSPITAL; TOWER TO HAVE ELEVATED LEVELS OF CO; hospital notified fire dept who evacuated hotel; victim Michael Brown said he began having symptoms the day before at hotel and collapsed, taken to hospital but released later and returned to his hotel room - CO poisoning not diagnosed until he collapsed again the following day, wife found him unconscious and took him back to hospital; they both were transferred to a nearby hospital for treatment in hyperbaric chamber; "investigators said the hotel has carbon monoxide detectors, but they did not go off. Instead someone had to pull the fire alarm to evacuate guests." Cause of CO leak was determined to be a "malfunctioning water heater in a mechanical room on the first floor."
WI	Madison	11/11/17		Doubletree Hotel	Y		8	Fire Dept responded to call for two guests who passed out in the stairwell by the pool; when they arrived, a CO sensor in their EMS bag began sounding; evacuated area and found CO levels at 150ppm in stairwell, 400ppm in pool room, and 2000-2500ppm inside boiler room for the pool; gas company determined "an exhaust pipe on one of the boilers had fallen off and was discharging exhaust into the room."
TX	Temple	12/14/17		Hilton Garden Inn	Y		2	EMS called for two guests complaining carbon monoxide related symptoms, transported to hospital; firefighters located and confirmed the source of the carbon monoxide
MD	Baltimore	2/1/18		Delta Hotel				underground electrical fire in a manhole near the hotel; Fire Dept reported "high levels" of CO in the sub-basement of the hotel, "firefighters monitored all levels of the hotel with guests to ensure the levels of carbon monoxide were safe"
NY	NYC- Manhattan	2/21/18		The Hotel on Rivington				hotel and three neighboring buildings evacuated due to CO created by "mahmole fires"; CO levels measured at 1400ppm
TX	Austin	2/21/18		Fairmont Hotel			2	hotel new and set to open in next few weeks; Fire Dept called to hotel for reports of a gas leak; found "high levels" of CO on first seven floors and evacuated workers; CO related to pizza oven in hotel's kitchen, "An exhaust system had failed, forcing the harmful gas to recirculate into the hotel's air conditioning system"; 2 hotel workers hospitalized
MO	Waford City	3/10/18		Little Missouri Inn & Suites			3	911 called for children in pool area having difficulty breathing; Fire Dept responded and determined CO exposure resulting from "a malfunction in the pool mechanic room ventilation system"
CO	Denver	5/22/18		Aloft Hotel (Marront)	Y		18	Rescuers called to hotel when a CO alarm went off (news article does not reference if it was hotel alarm but a reader comment states "The hotel did not detect the carbon monoxide, hotel guests did with their own equipment"); hotel evacuated, victims transported to hospital by ambulances and a hotel van
NH	Windham	6/4/18		Manor Motel - extended stay				motel manager quoted, "We had a carbon monoxide detector in the basement, in the laundry area, and the alarm was going off and one of the guests was nice enough to call me and tell me that she could hear...an alarm going off"; motel fully occupied and approximately half were evacuated due to leak; fire dept detected 2000ppm near the exterior of ventilation system and elevated levels inside some rooms; mouse nest discovered in exhaust pipe; technician cleaned out the system and was working on replacing the piping going out of the building"
VA	Hampton	6/6/18		Quality Inn	Y			firefighters responded and evacuated building
TX	San Antonio	7/24/18		Comfort Suites	Y		12	911 call at 1:40am for "a group" reporting they were ill from food poisoning; additional call for a second family with same symptoms prompted firefighters to check air quality; "found an exhaust pipe on a water heater that was disconnected and the exhaust was being sucked up by the room handlers"; "Investigators at the scene told reporter that the hotel did not have carbon monoxide detectors as local rules do not require it in hotels or motels"

IA	Ankeny	7/28/18		Fairfield Inn & Suites by Marriott	Y	3				One of three victims staying in same room was ill with dizziness and nausea, called for ambulance at approx 2am, emergency responders arrived and found all three victims ill, detected CO levels at 500ppm , additional ambulances called, hotel evacuated, gas company response, source of CO "faulty venting from the laundry"
CO	Longmont	10/29/18		Super 8	Y	1	boiler room	boiler room		Fire Dept responded to 2am call for guest who was feeling ill, transported to hospital where guest was "eventually" diagnosed with CO poisoning - hospital notified fire dept who then returned to the hotel and evacuated guests; high levels of CO found throughout building
NC	Jacksonville	11/2/18		Holiday Inn Express	Y	16	1 injured			police called to hotel around 3am for a strange odor, discovered high levels of CO and evacuated building; guests included victims of Hurricane Florence who had been displaced from their homes as well as federal employees in town to help hurricane victims
TN	Nashville	11/7/18		Westin	Y	14	heater			front desk called 911 when multiple guests from gym on third floor complained of feeling ill; firefighters responded and evacuated third and fourth floors of hotel; Fire Dept detected CO levels at 500ppm on the third floor; "A state ordinance, adopted by the city, only requires carbon monoxide detectors on floors where guests sleep. The third floor only has a pool and the workout room."
CO	Boulder	11/18/18	Raymond & Betty June Clark (both injured)	Hyatt Place Boulder	Y	2	boiler			victims entered into room on 11/17/18 and during 8-day stay were ill with bouts of vomiting, nausea and fainting; visited nearby emergency room four times during the week; leak discovered when victims were diagnosed with CO poisoning - hospital contacted Fire Dept. who then evacuated hotel; CO levels measured 500ppm in lobby, 2nd-5th floor rooms had levels "up to 200ppm "; 500ppm in boiler room; "maintenance engineer of the hotel initially told firefighters the hotel did not have any gas leaks to the hotel, but firefighters said there was a gas-fed boiler room that was the source of the carbon monoxide"; "fire department also directed the hotel to contact guests who had been staying at the hotel in the three days leading up to the evacuation to determine if any of them had symptoms"
MA	Foxborough	12/17/18		Renaissance Patriot Place Hotel	Y	1	boiler			CO detectors alerted staff to elevated CO levels; 60-70 guests and employees were evacuated from building by fire dept; "shut-out process took a while because the windows at the hotel do not open"
NY	Syracuse	1/1/19		Genesee Grande Hotel		5	boiler			CO alarm on first floor went off, manager "then went to the carbon monoxide reader in the basement and called 911"; Fire Dept. responded and evacuated "19 occupied rooms"; source of CO leak listed as "a faulty heating boiler"
MI	Charlevoix	1/1/19		Amencinn	Y	12	pool boiler			Fire Dept called to hotel for high carbon monoxide levels in the pool area; pool had no CO detector but when guests complained of feeling ill, staff brought one from another area - it alarmed and they called 911; CO levels measured at 90ppm in pool area; users of pool were guests and community members, hotel had opened pool up for community use to celebrate New Year's Day
CO	Aurora	1/29/19		Gaylord Rockies Resort & Convention Center		2	boiler room			Fire Dept responded to report of high levels of CO at convention center; according to hotel spokesperson, "high carbon monoxide levels were determined to be related to work taking place on the property...in the boiler room"
CO	Aurora	1/30/19		Gaylord Rockies Resort & Convention Center			boiler room			Fire Dept responded to reports of high levels of CO in same area as previous day (see previous case); no injuries reported
NJ	Cameys Point	2/15/19		Friendship Motel Inn		7				Authorities responded to hotel for a deceased child "who was 7 or 8"; police suspected CO poisoning and evacuated building; a family of 6 had elevated levels of CO in their blood and were taken to the hospital, a 7th guest had elevated levels but declined treatment; medical examiner ruled out CO poisoning as cause of death of child because "the child had been being treated for an infection prior to her death"; "The only source of gas in the motel was its gas hot water heater in the basement...but readings in the basement showed no excess carbon monoxide...it's possible a resident was cooking in a room"
SD	Pierre	3/15/19		Baymont Inn & Suites			furnace			Fire Dept responded at 3:24am after CO alarm alerted hotel staff; evacuated building; CO levels measured 40-60ppm , "extremely high" levels in fitness room; cause determined to be "a gas burning furnace whose exhaust outlet had been blocked by snow...a drift had covered up the vent"
MA	Saugus	4/7/19		Holiday Inn Express	Y					Fire Dept responded, hotel evacuated
VA	Norfolk	4/7/19		Quality Inn Suites	Y	1	pool heater			Fire Dept called at 7:25pm for report of a CO leak, first floor evacuated
NE	Omaha	5/10/19		Comfort Inn Suites	Y					Fire Dept responded, hotel evacuated
WY	Gillette	5/12/19		Travelodge by Wyndham	Y		water heater			Fire Dept responded "for a carbon monoxide detector activation...determined there was a malfunction with the water heater for the laundry facility"
PA	Erie	5/25/19		Days Inn	Y	2				Fire Dept evacuated hotel around 5pm; one victim found unresponsive

<p>Please help protect others by sharing this information</p>																			
<p>Be informed</p> <p>To date, there is no federal requirement for the installation of carbon monoxide alarms in hotels. Only 14 states require installation of CO alarms in hotels and motels under statute (www.ncsl.org). There currently are no federal requirements for carbon monoxide education and/or training of hotel owners and staff. No federal agency tracks CO incidents in U.S. hotels.</p> <p>Be aware and be safe when traveling</p> <p>Know the symptoms of carbon monoxide poisoning (you can't see it, smell it or taste it) and always carry your own carbon monoxide alarm when you travel. Alarms are sold online and in stores anywhere you find household smoke alarms.</p> <p>About this spreadsheet</p> <p>This is not an all-inclusive list of hotel/motel CO incidents, these are only the cases that had an associated media story, or were otherwise noted in a publicly accessible document online. Cases, both old and new, are added as they are discovered.</p> <p>All incidents and details listed were obtained via media accounts and publicly accessible documents. Those marked with * are courtesy of Dr. Lindell Weaver, author of the 2007 published article "Carbon Monoxide Poisoning at Motels, Hotels and Resorts" (Amer. Journal of Preventive Medicine)</p> <p>"Carbon Monoxide Poisonings in Hotels and Motels: The Problem Silently Continues" published in 2019 (Preventive Medicine Reports) by authors Dr. Neil Hampson, Dr. Lindell Weaver, Kris Hauschildt, and Kayla Deru, along with the 2007 article referenced above, provides collective published data on U.S. hotel CO incidents, 1989-2018.</p> <p>To add a case or additional information to this log, or to request an updated copy, email krishauschildt@yahoo.com</p> <p>This spreadsheet was compiled and is maintained by Kris Hauschildt in memory of Daryl & Shirley Jenkins and Jeffrey Williams who lost their lives to carbon monoxide poisoning in the same hotel room just a few weeks apart on April 16 and June 8, 2013.</p> <p>Daryl & Shirley Jenkins Foundation www.thejenkinsfoundation.com</p>																			



CO exposure limits
(over an 8-hour time-weighted average)

- OSHA: 50ppm**
Occupational Safety and Health Administration
- NIOSH: 35ppm**
National Institute for Occupational Safety and Health
- ACGIH: 25ppm**
American Conference of Govt Industrial Hygienists
- WHO: 8ppm**
World Health Organization



Hotel Carbon Monoxide Incident Data

Hotel Carbon Monoxide Incident Data

Carbon Monoxide (CO) is a colorless, odorless, tasteless gas. It is a byproduct of fossil fuel combustion from devices such as furnaces, pool heaters, automobiles, and gas ranges. Other devices and appliances may emit CO if they malfunction, are blocked, or are used improperly.

CO poisoning is the second most common cause of non-medicinal poisonings death. According to the CDC accidental CO poisonings account for 50,000 emergency department visits and 430 deaths each year in the U.S.

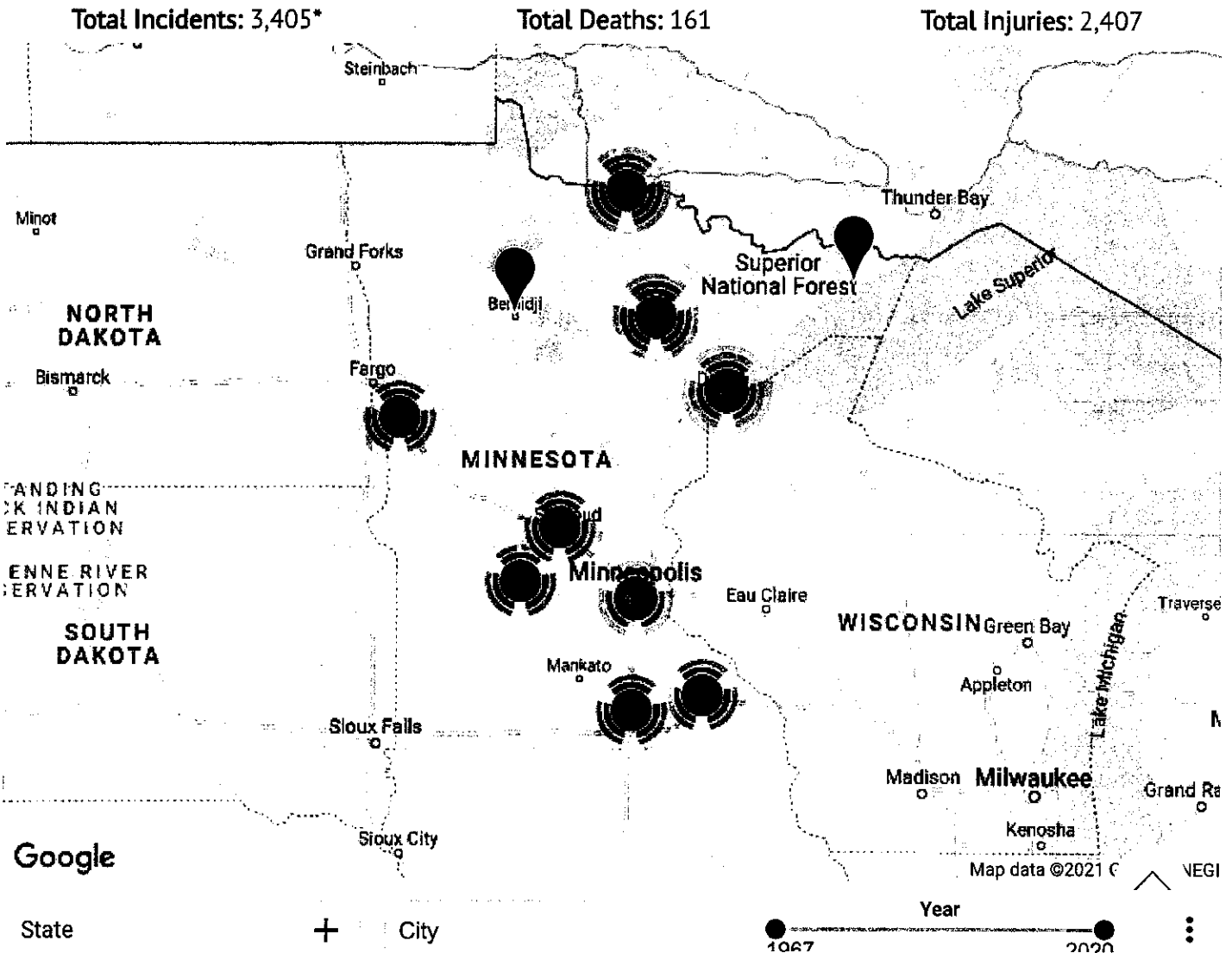
To date, there is no federal requirement for the installation of CO alarms in the hospitality industry (hotels and motels), and only 14 states require installation of CO alarms in hotels and motels under statute (www.ncsl.org). There are currently no requirements for carbon monoxide education and/or training of hotel owners and staff.

CO incidents in the hospitality industry are not currently tracked by any official government organization. REM is using data from two sources to generate the map and list of incidents below.



The National Fire Incident Reporting System (NFIRS) collects data from fire departments across the U.S. and is a "reporting standard that fire departments use to uniformly report on the full range of their activities, from fire to Emergency Medical Services (EMS) to severe weather and natural disasters." REM has utilized the 1999-2018 NFIRS databases to identify Fire Department calls occurring at properties with use type 449 (Commercial hotel or motel) and incident types 424 (Carbon monoxide incident). The number of hotel CO incidents identified were only second to those in restaurants or cafeteria property types. This data has not yet been verified independent of the NFIRS system.

Both the Jenkins Foundation and NFIRS data is shown in the map below. The Jenkins Foundation data is shown in Red, and the NFIRS data is shown in Blue. By default, both data sets (NFIRS and The Jenkins Foundation) are plotted simultaneously; the data source can be selected to view only one or the other data sets if needed. Specific incident details are available about each incident by selecting the indicator on the





Incident Details/Notes

CO Source

Data Source

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State	City	Date of Incident	Year	Name of Facility	# of Deaths	# Injured	CO Source	Data Source
MN	Rochester	2/16/1969	1969	Rochester Motel	1		gas heater	The Jer Founda
MN	Spicer	7/1/1990	1990	Cazador Inn		120	pool heater	The Jer Founda
MN	International Falls	5/6/2013	2013	AmericInn		1	pool heater	The Jer Founda
MN	Burnsville	11/29/2000	2000	Unknown			Unknown	NFIRS
MN	Hutchinson	5/21/2002	2002	Unknown			Unknown	NFIRS
MN	Rochester	10/25/2002	2002	Unknown			Unknown	NFIRS
MN	Brooklyn Park	12/6/2003	2003	Unknown			Unknown	NFIRS
MN	Brooklyn Park	12/13/2003	2003	Unknown			Unknown	NFIRS
MN	Brooklyn Park	12/13/2003	2003	Unknown			Unknown	NFIRS
MN	Brooklyn Park	12/13/2003	2003	Unknown			Unknown	NFIRS
MN	Elk River	1/24/2003	2003	Unknown			Unknown	NFIRS
MN	Rochester	9/8/2003	2003	Unknown			Unknown	NFIRS
MN	Brooklyn Park	8/3/2004	2004	Unknown			Unknown	NFIRS
MN	Hutchinson	2/1/2005	2005	Unknown			Unknown	NFIRS
MN	Hibbing	3/1/2005	2005	Unknown			Unknown	NFIRS
MN	Duluth	1/19/2005	2005	Unknown			Unknown	NFIRS
MN	Duluth	6/18/2006	2006	Unknown			Unknown	NFIRS
MN	Two Harbors	2/15/2007	2007	Unknown			Unknown	NFIRS
MN	Hibbing	10/27/2007	2007	Unknown			Unknown	NFIRS
MN	Albany	3/18/2007	2007	Unknown			Unknown	NFIRS

*3,405 incidents based on NFIRS data. The Jenkins Foundation has identified 367 incidents. The NFIRS data set does not track civilian injuries or deaths caused by CO incidents, the data indicates basic life support was administered during 29 incidents and advanced life support was administered during 25 incidents. Twelve incidents indicated persons were transported from the scene in an ambulance or other appa



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Incident Details/Notes

CO Source

Data Source

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State	City	Date of Incident	Year	Name of Facility	# of Deaths	# Injured	CO Source	Data Source
MN	Minneapolis	11/19/2010	2010	Unknown			Unknown	NFIRS
MN	Duluth	3/26/2010	2010	Unknown			Unknown	NFIRS
MN	Hastings	1/25/2010	2010	Unknown			Unknown	NFIRS
MN	Duluth	11/6/2010	2010	Unknown			Unknown	NFIRS
MN	New Prague	5/12/2011	2011	Unknown			Unknown	NFIRS
MN	Proctor	11/20/2011	2011	Unknown			Unknown	NFIRS
MN	Roseville	12/16/2011	2011	Unknown			Unknown	NFIRS
MN	Fergus Falls	1/7/2011	2011	Unknown			Unknown	NFIRS
MN	Owatonna	11/19/2012	2012	Unknown			Unknown	NFIRS
MN	Bloomington	4/20/2013	2013	Unknown			Unknown	NFIRS
MN	International Falls	5/9/2013	2013	Unknown			Unknown	NFIRS
MN	Shakopee	11/30/2013	2013	Unknown			Unknown	NFIRS
MN	Bloomington	12/5/2013	2013	Unknown			Unknown	NFIRS
MN	Bloomington	12/20/2013	2013	Unknown			Unknown	NFIRS
MN	Bemidji	12/30/2013	2013	Unknown			Unknown	NFIRS
MN	Duluth	6/7/2013	2013	Unknown			Unknown	NFIRS
MN	Deer River	5/13/2013	2013	Unknown			Unknown	NFIRS
MN	Litchfield	12/11/2013	2013	Unknown			Unknown	NFIRS
MN	Bloomington	4/10/2015	2015	Unknown			Unknown	NFIRS
MN	St Louis	12/12/2015	2015	Unknown			Unknown	NFIRS
MN	Willmar	1/11/2015	2015	Unknown			Unknown	NFIRS
MN	Willmar	2/21/2015	2015	Unknown			Unknown	NFIRS
MN	Eden Prairie	1/11/2016	2016	Unknown			Unknown	NFIRS
MN	Brooklyn	1/22/2016	2016	Unknown			Unknown	NFIRS
MN	Moorhead	1/29/2016	2016	Unknown			Unknown	NFIRS

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Incident Details/Notes

CO Source

Data Source

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State	City	Date of Incident	Year	Name of Facility	# of Deaths	# Injured	CO Source	Data Source
MN	Bloomington	7/11/2016	2016	Unknown			Unknown	NFIRS
MN	Maple Grove	1/30/2016	2016	Unknown			Unknown	NFIRS
MN	Woodbury	8/1/2016	2016	Unknown			Unknown	NFIRS
MN	Eagan	7/30/2016	2016	Unknown			Unknown	NFIRS
MN	Lakeville	10/1/2016	2016	Unknown			Unknown	NFIRS
MN	Richfield	7/22/2017	2017	Unknown			Unknown	NFIRS
MN	Richfield	7/30/2017	2017	Unknown			Unknown	NFIRS
MN	Ramsey	4/27/2017	2017	Unknown			Unknown	NFIRS
MN	Ramsey	8/26/2017	2017	Unknown			Unknown	NFIRS
MN	Two Harbors	6/29/2017	2017	Unknown			Unknown	NFIRS
MN	Proctor	3/18/2017	2017	Unknown			Unknown	NFIRS
MN	Willmar	8/17/2017	2017	Unknown			Unknown	NFIRS
MN	Willmar	8/18/2017	2017	Unknown			Unknown	NFIRS
MN	Saint Cloud	4/8/2017	2017	Unknown			Unknown	NFIRS
MN	Saint Cloud	10/13/2017	2017	Unknown			Unknown	NFIRS
MN	Duluth	11/14/2018	2018	Unknown			Unknown	NFIRS
MN	Bloomington	10/16/2018	2018	Unknown			Unknown	NFIRS
MN	Rochester	2/19/2018	2018	Unknown			Unknown	NFIRS
MN	Rochester	3/5/2018	2018	Unknown			Unknown	NFIRS
MN	Grand Marais	7/12/2018	2018	Unknown			Unknown	NFIRS
MN	Northfield	1/24/2018	2018	Unknown			Unknown	NFIRS
MN	Eagan	2/28/2018	2018	Unknown			Unknown	NFIRS
MN	Saint Cloud	5/14/2018	2018	Unknown			Unknown	NFIRS
MN	Roseville	6/11/2018	2018	Unknown			Unknown	NFIRS
MN	Duluth	6/23/2018	2018	Unknown			Unknown	NFIRS

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Incident Details/Notes

CO Source

Data Source

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State	City	Date of Incident	Year	Name of Facility	# of Deaths	# Injured	CO Source	Data So
MN	Rochester	1/23/2018	2018	Unknown			Unknown	NFIRS
MN	Roseville	7/14/2018	2018	Unknown			Unknown	NFIRS
MN	Cannon Falls	1/14/2014	2014	Unknown			Unknown	NFIRS
MN	Eden Prairie	8/5/2014	2014	Unknown			Unknown	NFIRS
MN	St Paul	3/1/2014	2014	Unknown			Unknown	NFIRS
MN	Hastings	1/18/2014	2014	Unknown			Unknown	NFIRS
MN	North Branch	11/23/2014	2014	Unknown			Unknown	NFIRS
MN	Hastings	12/8/2014	2014	Unknown			Unknown	NFIRS

*3,405 incidents based on NFIRS data. The Jenkins Foundation has identified 367 incidents. The NFIRS data set does not track civilian injuries or deaths caused by CO incidents, the data indicates basic life support was administered during 29 incidents and advanced life support was administered during 25 incidents. Twelve incidents indicated persons were transported from the scene in an ambulance or other apparatus. The injury and death data provided in the summary above the map are based on The Jenkins Foundation Data.



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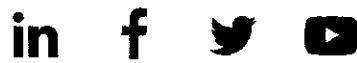
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Natural Disasters, Severe Weather, and COVID-19

Know how the COVID-19 pandemic can affect disaster preparedness and recovery, and what you can do to keep yourself and others safe.

Clinical Guidance for Carbon Monoxide (CO) Poisoning

Carbon monoxide (CO) is an odorless, colorless, 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. 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.

How to Recognize CO Poisoning: The symptoms and signs of carbon monoxide poisoning are variable and nonspecific. The most common symptoms of CO poisoning are headache, dizziness, weakness, nausea, vomiting, chest pain, and altered mental status.

The clinical presentation of CO poisoning is the result of its underlying systemic toxicity. Its effects are caused not only by impaired oxygen delivery but also by disrupting oxygen utilization and respiration at the cellular level, particularly in high-oxygen demand organs (i.e., heart and brain).

Symptoms of severe CO poisoning include malaise, shortness of breath, headache, nausea, chest pain, irritability, ataxia, altered mental status, other neurologic symptoms, loss of consciousness, coma, and death; signs include tachycardia, tachypnea, hypotension, various neurologic findings including impaired memory, cognitive and sensory disturbances; metabolic acidosis, arrhythmias, myocardial ischemia or infarction, and noncardiogenic pulmonary edema, although any organ system might be involved.

With a focused history, exposure to a CO source may become apparent. Appropriate and prompt diagnostic testing and treatment is very important.

Red Flags: No fever associated with symptoms, history of exposure, multiple patients with similar complaints.

Sources of CO Poisoning

- Gas-powered generators
- Charcoal grills, propane stoves, and charcoal briquettes for both cooking and heating indoors
- Motor vehicles
- Fire
- Boats
- Power washers and other gas powered tools.

At-risk Populations include:

- Babies and infants
- Pregnant women
- The elderly
- People with chronic heart disease, anemia or respiratory illness.

Evaluation

- Diagnosis is based on a suggestive history and physical findings coupled with confirmatory testing. Patients should be examined for other conditions, including smoke inhalation, trauma, medical illness, or intoxication.
- Neurological exam should include an assessment of cognitive function such as a Mini-Mental Status Exam
- All women of childbearing age who are suspected of having CO poisoning should have a pregnancy test.

Confirmation of diagnosis

- The key to confirming the diagnosis is measuring the patient's carboxyhemoglobin (COHgb) level.
 - COHgb levels can be tested either in whole blood or pulse oximeter.
 - It is important to know how much time has elapsed since the patient has left the toxic environment, because that will impact the COHgb level. If the patient has been breathing normal room air for several hours, COHgb testing may be less useful.
- The most common technology available in hospital laboratories for analyzing the blood is the multiple wavelength spectrophotometer, also known as a CO-oximeter. Venous or arterial blood may be used for testing.
- A fingertip pulse CO-oximeter can be used to measure heart rate and oxygen saturation, and COHgb levels. The conventional two-wavelength pulse oximeter is not accurate when COHgb is present.
- COHgb levels do not correlate well with severity of illness, outcomes or response to therapy so it is important to assess clinical symptoms and history of exposure when determining type and intensity of treatment.
- Other testing, such as a fingerstick blood sugar, alcohol and toxicology screen, head CT scan or lumbar puncture may be needed to exclude other causes of altered mental status when the diagnosis of carbon monoxide poisoning is inconclusive.
- Note: carbon monoxide can be produced endogenously as a byproduct of heme metabolism. Patients with sickle cell disease can have an elevated COHgb level as a result of hemolytic anemia or hemolysis.

An elevated COHgb level of 2% for non-smokers and >9% COHgb level for smokers strongly supports a diagnosis of CO poisoning.

Guidance for Management of Confirmed or Suspected CO Poisoning

- Administer 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.
- Consider hyperbaric oxygen therapy (HBO) therapy when the patient has a COHgb 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 COHgb (<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.

Other Considerations

- Cardiac injury during poisoning increases risk of mortality over 10 years following poisoning, so in patients with severe CO poisoning, it may be important to perform an EKG and measurement of troponin and cardiac enzymes.
- Chest radiography is recommended for seriously poisoned patients, especially those with loss of consciousness or cardiopulmonary signs and symptoms. Brain computed tomography or MRI is also recommended in these cases; these tests may show signs of cerebral infarction secondary to hypoxia or ischemia.
- All discharged patients should be warned of possible delayed neurological complications and given instructions on what to do if these occur. Follow-up should include a repeat medical and neurological exam in 2 weeks.

Related information

- [CDC Carbon Monoxide Poisoning](#)



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Carbon Monoxide Levels Chart

March 12, 2020

Carbon monoxide exposure is the most common method of death by poisoning in the world.

The effects of carbon monoxide poisoning are well understood. CO gas competes with oxygen to bind with hemoglobin in the blood leading to a reduction of oxygen in the brain. Even low carbon monoxide levels over long periods can have an impact on brain chemistry.

While exact short term and long term CO levels recommended by ASHRAE, OSHA, NIOSH and other organizations differ, the consensus is that 9 ppm (parts-per-million) is the maximum indoor safe carbon monoxide level over 8 hours.

Click the links below to see each organization's safe carbon monoxide levels and exposure limits:

1. [OSHA: Occupational Safety and Health Association](#)
2. [ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers](#)
3. [NIOSH: National Institute for Occupational Safety and Health](#)
4. [ACGIH: American Conference of Governmental Industrial Hygienists](#)
5. [EPA: Environmental Protection Agency](#)
6. [WHO: World Health Organization](#)
7. [UL, CSA, ANSI: Underwriters Laboratories](#)

CARBON MONOXIDE LEVELS CHART

0 ppm	Recommended Safe Level	
6 ppm	WHO 24 Hour Average	
9 ppm	ASHRA 8 Hour Average EPA 8 hour 8 Hour Average NAAQS 8 Hour Average WHO 8 Hour Average	
25 ppm	ACGIH 8 Hour Average	
30 ppm	WHO 1 Hour Average	
35 ppm	NIOSH 8 Hour Average NAAQS 1 Hour Average	Physical symptoms after 6-8 hours.
50 ppm	OSHA 8 hour Average (PEL)	
30-69 ppm	UL 30 Day Alarm	
87 ppm	WHO 15 Minute Average	
70-149 ppm	UL 1-4 Hour Alarm	
200 ppm	NIOSH 15 minute STEL	Physical symptoms after 2-3 hours.
150-399 ppm	UL 10-50 Minute Alarm	Physical symptoms in 1-2 hours. Life threatening 3 hours.
400+ ppm	UL 4 Minute Alarm	Physical symptoms in 45 minutes. Unconscious in 2 hours. Fatal in 2-3 hours.
800 ppm		Physical symptoms in 20 minutes. Fatal within 1 hour.
1,600 ppm		Physical symptoms in 5-10 minutes. Fatal within 25-30 minutes.
3,200 ppm		Physical symptoms in 1-2 minutes. Fatal within 10-15 minutes.
6,400 ppm		
12,800 ppm		Fatal within 1-3 minutes.

Physical Symptoms

physical symptoms may include headache, fatigue, dizziness and/or nausea.

[Download a copy of the chart here.](#)

OSHA Carbon Monoxide Exposure Limits

The Occupational Safety and Health Association OSHA sets standards for working conditions in the US including safe carbon monoxide levels.

The OSHA personal exposure limit (PEL) for CO is 50 parts per million (ppm). OSHA standards prohibit worker exposure to more than 50 parts of CO gas per million parts of air averaged during an 8-hour time period. The 8-hour PEL for CO in maritime operations is also 50 ppm. Maritime workers, however, must be removed from exposure if the CO concentration in the atmosphere exceeds 100 ppm. The peak CO level for employees engaged in roll-on roll-off operations during cargo loading and unloading is 200 ppm.

ASHRAE Carbon Monoxide Exposure Limits

The American Society of Heating, Refrigerating and Air-Conditioning Engineers ASHRAE is a voluntary world-wide organization that sets standards for members focused on building systems, energy efficiency, indoor air quality, refrigeration and sustainability. The ASHRAE Standard 62.1-2016, "Ventilation for Acceptable Indoor Air Quality" agrees with the US Environmental Protection Agency and the World Health Organization limit of 9 ppm over an 8 hour exposure.

NIOSH Carbon Monoxide Levels Exposure Limits

The National Institute for Occupational Safety and Health NIOSH is the US federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. The Occupational Safety and Health Act of 1970 established NIOSH as a research agency focused on the study of worker safety and health, and empowering employers and workers to create safe and healthy workplaces.

NIOSH recommends no more than 35 ppm time weighted average TWA exposure limit. In addition, NIOSH recommends no more than 200 ppm short term exposure limit STEL for 15 minutes.

ACGIH Carbon Monoxide Levels Exposure Limits

The American Conference of Governmental Industrial Hygienists ACGIH is a non-profit organization that advances occupational and environmental health.

The ACGIH recommends a Threshold Limit Value – Time-Weighted Average (TLV-TWA) 50 ppm with a TLV- short term exposure limit of 400 ppm. A TLV-TWA is defined as the concentration of a hazardous substance in the air averaged over an 8-hour workday and a 40-hour workweek to which

it is believed that workers may be repeatedly exposed, day after day, for a working lifetime without adverse effects.

EPA Carbon Monoxide Levels Exposure Limits

The United States Environmental Protection Agency EPA sets national ambient air quality standards (NAAQS) under authority of the Clean Air Act (42 U.S.C. 7401 et seq.). NAAQS is applied for outdoor air throughout the country.

The NAAQS standard for carbon monoxide in outdoor air is 9 ppm over 8 hours and 35 ppm over 1 hour not to be exceeded more than once a year.

WHO Carbon Monoxide Levels Exposure Limits

The World Health Organization WHO suggests maximum carbon monoxide levels both in response to their mandate for outdoor clean air and to help countries develop indoor air quality building standards. In indoor environments, space heaters fueled with oil, gas or kerosene, gas stoves, combustion appliances and tobacco smoking are known to cause significant emissions of carbon monoxide. The WHO recommended limits are:

- 9-10 ppm for no more than 8 hours
- 25-35 ppm for no more than 1 hour
- 90-100 ppm for no more than 15 minutes

UL, CSA, ANSI CO Levels Exposure Limits

Underwriters Laboratories UL is the largest and best known independent, not-for-profit testing laboratory in the world. It conducts product evaluations to confirm that the products meet the "UL" standard in electrical safety, fire testing, medical device testing, EMC testing and more.

American National Standards Institute ANSI works in close conjunction with Underwriters Laboratories, and many of the standards are listed as ANSI/UL. UL also has a close association and shares product ratings with the [CSA Group](#) which is accredited by the Standards Council of Canada.

The ANSI/UL 2034, ANSI/UL 2075 and CSA 6.19-01 “Standard for Safety for Single and Multiple Station Carbon Monoxide Alarms” requirements are purchased by manufacturers before submitting their devices for testing. They are not normally available to the public. However, UL-certified CO alarms meet a different range of standards that balance the responsiveness of the alarm with the requirement that they not generate nuisance alarms due to background CO caused by outdoor pollution, the normal use of fuel burning appliances or other vapors like methane or ammonia.

The alarm thresholds, set by CO concentration measured in parts per million (ppm), are: no alarm below 30 ppm until after 30 days; 70 ppm for one to four hours (but not less than one hour); 150 ppm for 10 to 50 minutes; 400 ppm for four to 15 minutes.

Carbon Monoxide Meters

A useful and inexpensive solution for measuring CO is a [Portable Carbon Monoxide Detector](#). Designed for personal use, this battery operated CO detector quickly tells you if CO levels are high in the house, basement, garage, RV or cabin cruiser boats with inboard motors.

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October 2005

Causes and clinical significance of increased carboxyhemoglobin

by Chris Higgins

Hemoglobin is the oxygen-carrying protein contained in red blood cells (erythrocytes). Although normally present in only trace amounts, there are three species of hemoglobin that cannot transport oxygen.

The three species, collectively called dyshemoglobins because of their functional redundancy, are methemoglobin, sulfhemoglobin and carboxyhemoglobin.

The last of these is the subject of this article. Carboxyhemoglobin (COHb), which normally comprises less than 1-2 % of total hemoglobin, is the product of reaction between carbon monoxide and hemoglobin.

Carbon monoxide is produced endogenously but is also a common environmental pollutant; both sources contribute to the amount of COHb in blood. The focus of this article is causes and clinical significance of an increased amount of COHb. Three illustrative case histories will be discussed.

It begins, however, with a brief review of some relevant physiology.

NORMAL PHYSIOLOGY

Normal cell function is crucially dependent on a continuous supply of oxygen, and a principle function of blood is delivery of oxygen in inspired air from lungs to every tissue cell.

This essential gas transport function depends on the protein hemoglobin (Hb) contained in red blood cells (erythrocytes).

Structure and function of hemoglobin

Each of the 5×10^{10} erythrocytes contained in every mL of blood contains 280 million Hb molecules. The Hb molecule comprises four polypeptide subunits (the globin portion) each of which has a heme group attached [1].

At the center of the four heme groups is an atom of iron in the ferrous state. Oxygen binds reversibly to these four iron atoms; the product is oxyhemoglobin (O₂Hb).

The oxygen transport function of hemoglobin, that is its ability to pick up oxygen in the lungs, transport it around the body as O₂Hb and then release it to tissue cells, is made possible by a change in the quaternary structure of the hemoglobin molecule, which alters the affinity of hemoglobin for oxygen.

The quaternary state and consequent affinity of hemoglobin for oxygen is governed principally by local partial pressure of oxygen (pO_2), although pH, pCO_2 and organic phosphate concentration are important modulating factors.

In the environment of the lungs, where conditions (high pO_2 , low pCO_2) determine that hemoglobin has a relatively high affinity for oxygen, O₂Hb is readily formed.

By contrast in the tissues, local conditions (low pO_2 , raised pCO_2) result in reduced hemoglobin affinity for oxygen, thus favoring release of oxygen from hemoglobin to tissue cells. The relationship between pO_2 and the relative affinity of Hb for oxygen is described in the oxygen saturation curve (Figure I).

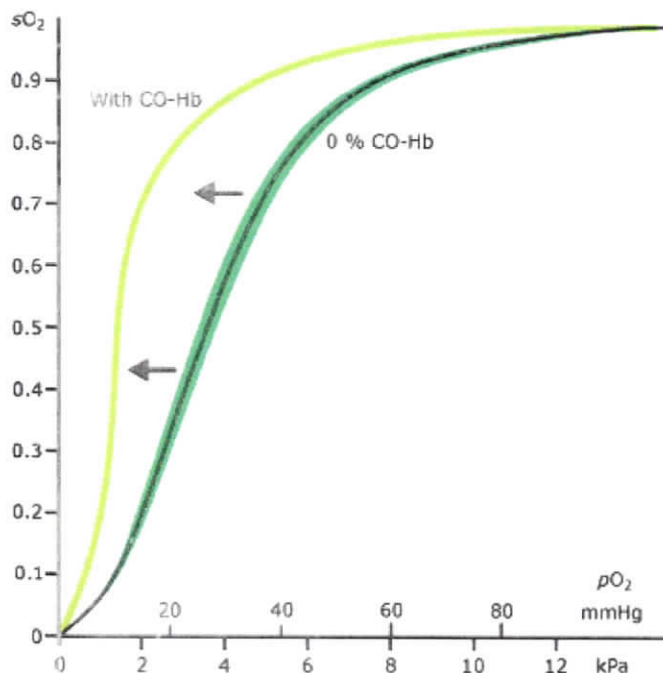


FIGURE I

Oxygen has to compete with other hemoglobin-binding ligands that may be present in blood for occupation of hemoglobin binding sites; among these is carbon monoxide, a colorless odorless gas produced during normal metabolism.

Endogenous production of carbon monoxide

It is more than 50 years since Sjostrand first demonstrated that carbon monoxide (CO) is produced during normal metabolism [2]. In fact, around 0.4 mL CO is produced every hour almost exclusively from the catabolism of heme-containing proteins [3].

The most abundant heme-containing protein and therefore the source of most endogenous CO is hemoglobin. At the end of their 120-day life, erythrocytes are sequestered from the circulation by the reticuloendothelial system.

Hemoglobin released from senescent erythrocytes is degraded to its constituent parts: heme and protein polypeptide. The protein is recycled but heme is metabolized further.

In a reaction catalyzed by the rate-limiting enzyme heme oxygenase, heme is converted to equimolar quantities of biliverdin, iron and CO. Biliverdin is subsequently converted to the yellow pigment bilirubin, which is excreted by the liver in bile, and iron is recycled.

Catabolism of heme derived from other heme-containing proteins, e.g. myoglobin and the cytochromes, contribute to endogenous production of CO by the same heme-oxygenase-mediated route.

There is evidence that CO is also derived from non-heme sources, e.g. lipid peroxidation [4], but compared to that derived from catabolism of heme, this is of very minor significance, indeed may only occur in pathological situations.

The biological effect of endogenous CO is due largely to the high affinity that heme has for CO and the resulting binding of CO by heme-containing proteins. By a curious quirk of nature then, heme is both the source of CO and the mediator of its biological effect.

The modulation in function of some heme-containing proteins that results from CO binding has important physiological effects.

Thus endogenously produced carbon monoxide is not, as was once supposed, simply a potentially toxic waste product of metabolism but is involved in many physiological functions, including regulation of respiration [5], neuronal signaling [6], regulation of blood pressure [7] and uterine contraction during pregnancy [8].

Of all heme-containing proteins, Hb is not only the most abundant but also exhibits the highest affinity for carbon monoxide, so that most CO in blood is bound to Hb.

Reversible binding occurs at the same iron atom on the heme site where oxygen binds; the product of this binding is carboxyhemoglobin (COHb).

This provides the means by which endogenous carbon monoxide can be transported, prior to elimination from the body by the lungs in expired air. A minimum of 0.5-1.0 % COHb is inevitably present in blood as a result of endogenously produced CO [9].

Environmental sources of carbon monoxide

In addition to the CO produced endogenously, the air we breathe contains CO, partly the result of natural processes but mostly from the incomplete combustion of hydrocarbons.

The most significant unnatural source of environmental CO is motor-vehicle exhaust. Although normally present at concentrations of less than 10 parts per million (ppm) [10], carbon monoxide in inspired air has an important additive effect on the amount of COHb in blood due to the high affinity that Hb exhibits for CO.

The combined effect of endogenous and environmental CO results in a COHb of less than 3 % for most non-smoking urban dwellers and may be just 1-2 % for those living in rural areas where air is less polluted with CO.

Cigarette smoke contains a high concentration of CO and smokers are exposed to an estimated 400-500 ppm CO while smoking and consequently have much higher COHb. A necessary consensus, given the variability level of COHb due to environmental CO, suggests an absolute upper limit of normal COHb of 3 % for non-smokers and 10 % for heavy smokers [11].

CAUSES OF RAISED COHb

The amount of COHb in blood is determined principally by the amount of CO in blood. The source of the CO in blood is both endogenous (heme catabolism) and environmental (CO content of inspired air) so that the causes of raised COHb can be addressed under two main headings:

- Increased endogenous production of CO
- Breathing air polluted with high CO content – carbon-monoxide poisoning

Increased endogenous production of CO

Increased endogenous production of CO is a feature of any condition associated with increased heme catabolism. The hemolytic anemias are a group of conditions of variable etiology whose common pathological feature is increased rate of red-cell destruction (hemolysis).

Increased red-cell destruction results in increased heme catabolism and therefore increased production of CO. The severity of hemolysis correlates closely to CO production and measured COHb [12, 13].

In general, COHb increases due to hemolysis are of the order of only 2-3 %, but they can be higher. In one series of 75 neonates suffering hemolytic jaundice [14], five had COHb values in excess of 4 % and one baby with severe hemolysis had a level of 8.3 %. (The normal neonatal COHb range determined for this study was 0.15-0.75 %.)

It is rare for COHb to exceed 10 % in non-smokers, even in the most severe hemolytic episodes.

Slight increase in COHb – so slight to be of little clinical significance per se – is often a feature of severe inflammatory disease, e.g. sepsis, pneumonia [15]. It is thus a relatively common finding in critically ill patients [16].

The mechanism of this increase is thought to be increased expression of heme oxygenase (the enzyme responsible for CO production) induced by inflammatory cytokines [17].

Increased endogenous production of CO can arise independently of heme catabolism. Methylene chloride (dichloromethane) is a toxic organic solvent with wide application, including paint remover, degreaser and aerosol propellant. The toxicity of methylene chloride is due in part to its *in vivo* metabolism in the liver to CO.

Subjects who inhale toxic amounts of methylene chloride vapor, usually a result of working in poorly ventilated conditions, have raised COHb caused by increased production of CO. COHb levels, which can be severe enough to threaten life, correlates well with methylene chloride exposure levels [18].

Breathing air polluted with high CO content – carbon-monoxide poisoning

This is clinically the most significant cause of increased COHb for two reasons. First it is a more common cause of increased COHb than endogenous production of CO, and secondly it can result in a much more severe increase in COHb.

Most clinical requests for measurement of COHb are made in the context of known or suspected acute or chronic carbon-monoxide poisoning.

Epidemiology of carbon-monoxide poisoning

Deliberate or accidental poisoning by carbon monoxide remains a significant problem. In the US, it accounts for an estimated 40,000 emergency room attendances and between 5,000 and 6,000 deaths each year [19].

Most of these are suicides, usually the result of deliberate exposure to motor-vehicle exhaust, but still 600 deaths a year result from accidental exposure to carbon monoxide from a wide variety of sources. In the UK, CO is responsible for 50 deaths and 200 serious injuries every year [20].

Internationally, CO may be responsible for more than half of all fatal poisonings worldwide [21]. Low-grade carbonic CO poisoning is associated with non-specific symptoms and requires a high degree of suspicion for diagnosis, and most authorities believe many cases remain undiagnosed or misdiagnosed [22].

Sources of carbon monoxide

Carbon monoxide is a ubiquitous product of incomplete combustion of hydrocarbons. Common sources of CO in cases of poisoning include house fire, motor-vehicle exhaust and faulty domestic heating systems.

Less commonly, gas ovens, paraffin (kerosene) heaters and even charcoal briquettes, e.g. for use on barbeques, have been implicated.

Cleanly a closed or poorly ventilated environment is an important contributory factor in most cases, but it remains possible to suffer severe, even fatal, CO poisoning in the outdoors if close enough to a rich source of CO, e.g. swimming near boat exhaust [23].

Effect of CO exposure on COHb levels

The amount of COHb in blood is a function of both inspired CO concentration (parts per million, ppm) and duration of exposure.

During exposure to a fixed CO concentration, COHb levels increase rapidly over the first 2 hours, then begin to plateau at around 3 hours, reaching an equilibrium steady state at 4-6 hours. Table I describes the relationship between CO exposure and equilibrium COHb.

CO concentration of inspired air (ppm)	COHb %
70	10
120	20
220	30
350-520	40-50
800-1200	60-70
1950	80

To maintain COHb below 2.5 % all the time
CO exposure cannot exceed 10 ppm

CO concentration in specific environments:

- Global background: 0.05-0.12 ppm
- Urban traffic environment: 17 ppm overall with peaks of up to 53 ppm
- Underground car parks, road tunnels: up to 100 ppm may peak even higher
- Environmental tobacco smoke (offices, restaurants): 20-40 ppm (8-hour average)
- Workplace safety limit: 50 ppm (8-hour average)

TABLE 2: Data relating CO exposure to % COHb and CO concentration in specific environments

CONSEQUENCES OF RAISED COHb

Toxicity of carbon monoxide

The toxicity of CO is due in part to the effect that hemoglobin binding of CO has on the oxygen-carrying capacity of blood. Affinity of hemoglobin for CO is 200-250 times greater than that for oxygen [9, 20, 23, 24].

CO displaces oxygen from hemoglobin and thus COHb effectively reduces the oxygen-carrying capacity in a dose-dependant manner. In addition, binding of CO by Hb at the first of the four heme sites has an effect on its quaternary structure that results in decreased affinity for oxygen at the remaining three sites.

This effect is evident in a shift of the hemoglobin dissociation curve to the left (Figure 1) and results in reduced release of oxygen from hemoglobin at the tissues. The combined effect of a reduced oxygen-carrying capacity and reduced release of oxygen to tissue leaves tissues effectively starved of oxygen (hypoxic).

Organs like the brain and heart, whose normal oxygen consumption is by comparison with other organs relatively high, are particularly sensitive to the relative anoxia induced by increased COHb.

Fetal Hb exhibits an even higher affinity for CO than adult Hb, so that since CO diffuses readily across the placental membrane, the developing fetus is particularly vulnerable to tissue anoxia in cases of maternal CO exposure [26].

If increased production of COHb were, as was once supposed, the only mechanism involved in CO toxicity, then the severity of symptoms would be accurately predicted by the level of COHb, but this is not always the case.

It is now clear that "free" CO dissolved in blood plasma enters tissues and competes with oxygen for sites on tissue-cell heme proteins such as myoglobin, peroxidase and the cytochrome enzymes with a variety of pathological effects independent of hemoglobin CO binding [20].

Clinical sign and symptoms of carbon-monoxide poisoning

A high index of suspicion is required to entertain a diagnosis of carbon-monoxide poisoning unless CO exposure is certain, because all symptoms of mild-to-moderate poisoning are non-specific. The classic "cherry-red" skin color of carbon-monoxide poisoning is in fact not usually evident.

The most common symptoms: headache, dizziness and confusion reflect the marked sensitivity of the brain to relative anoxia. Nausea and vomiting are also common.

Affected patients may be breathless, particularly on exertion, and have clinical signs (tachycardia, tachypnea) indicating compensation for the oxygen deficit.

In more severe cases there are frank signs and symptoms of cardiac involvement, including palpitations, hypotension, ischemic chest pain (angina) and even myocardial infarction. Convulsions and coma occur in severe toxicity.

Exposure to carbon monoxide at concentrations greater than 1,900 ppm is immediately fatal.

A raised COHb in the absence of a disease process associated with the hemolytic process is diagnostic of carbon-monoxide poisoning; the actual level correlates with the severity of symptoms in the majority of cases (Table II).

Carboxyhemoglobin in blood %	Symptoms
10	No appreciable effect except shortness of breath on vigorous exertion, possible tightness across forehead
20	Shortness of breath on moderate exertion, occasional headache
30	Headache, easily fatigued, judgement disturbed, dizziness, dimness of vision
40-50	Headache, confusion, fainting, collapse
60-70	Unconsciousness, convulsions, respiratory failure, death if exposure continues
80	Immediately fatal

TABLE II: Relationship between % CO-Hb and symptoms

SOME ILLUSTRATIVE CASE HISTORIES

Case history 1: Severe CO poisoning with only marginally raised COHb

This case [27] concerns a 13-year-old boy who started his motorbike in the family garage. Before he could get to the garage door he was overcome by the exhaust fumes and collapsed. He was found unconscious around 9 hours after he was last seen, wedged between the family car and the unopened garage door.

Although by now there was no evidence of CO exposure, e.g. running motor or smell of exhaust, the moribund boy was suffering the effects of severe CO inhalation. After initial assessment at the local hospital, his respiration, already "rapid and labored" on admission, deteriorated and he was intubated and transferred to a tertiary referral center, some 13 hours after he was found.

The cause of his continuing unconscious state remained a mystery at this time. On admission to the second hospital, blood was sampled for COHb estimation. The laboratory reported a COHb of 4.9 %.

The boy remained deeply comatose for 10 days and was dependent on mechanical ventilation for 11 days. During this time, convulsions were frequent. Other significant complications included acute renal failure and severe muscle necrosis. Neurological recovery was gradual.

Although apparently alert by day 12, at first he was unable to recognize family members, unable to speak, had no memory and his control of movement was greatly restricted.

At six weeks, his memory had improved sufficiently to recall the events of the day of the accident, and he was able to confirm exposure to motorbike exhaust fumes. Eight weeks after admission he was eventually discharged to a rehabilitation unit, still with some restriction of movement of his lower limbs.

The CO exposure had left him with some impairment of short- and long-term memory, reduced ability to concentrate and a probable IQ deficit.

This is a case history of severe, near-fatal CO exposure with typically severe neurological sequelae. Such severe exposure would normally be associated with very high COHb, possibly in the range of 40-50 %, certainly greater than 20 %. Why then was the COHb only 4.9 %? After all, most smokers endure a COHb > 5 %.

The answer lies in the temporal relationship between exposure and blood sampling and highlights an important indication of COHb measurement for diagnosis of CO poisoning.

COHb has a half-life of only 4 hours when breathing room air; this is reduced to 90 minutes when breathing 100 % oxygen and less than 30 minutes if hyperbaric oxygen is instituted [10]. This is the rationale for the use of 100 % oxygen or hyperbaric oxygen in the treatment of CO poisoning.

However, it also means that if there is more than a few hours delay between exposure and sampling of blood, COHb will not accurately reflect exposure. In this case, 13 hours elapsed between the time the boy was found and the time blood was sampled.

Given a half-life of 4 hours, this is time enough for COHb to drop from a peak of say 40 % to 5 %. Whilst a raised COHb always indicates CO poisoning, a normal COHb is not sufficient to exclude a diagnosis of CO poisoning if there has been delay between exposure and blood sampling, especially if

oxygen therapy has been administered.

Case history 2: An unusual cause of raised COHb

The patient was a critically ill 41-year-old non-smoking male who had been transferred from his local intensive care unit to a tertiary referral center for continued management of large bilateral spontaneous adrenal hemorrhage [28].

On day 6 after referral, blood gas analysis revealed a COHb of 3.9 %, which increased to a maximum of 6.4 % three days later and fluctuated between 1.7 % and 5.6 % for the following two weeks.

Despite repeated transfusion of fresh frozen plasma to correct the presumed causative coagulopathy, internal bleeding continued and on day 14 at exploratory laparotomy, a 4,000 mL hematoma was removed. Biopsy of the adrenal gland revealed a benign tumor (pheochromocytoma) as the cause of bleeding.

Both before referral and for the following 14 days, repeated transfusion of packed red cells were needed to maintain hemodynamic stability. Despite continued intensive care and several further surgical interventions, including adrenalectomy, the patient's condition deteriorated and he died 58 days after referral.

The principle cause of raised COHb in this case was increased endogenous production of carbon monoxide. This was due to the ongoing degradation of hemoglobin within the retroperitoneal hematoma formed as a result of accumulating blood.

An additional contributory factor may have been the repeated red-cell transfusions. There is evidence that some packed red cells for transfusion may have COHb levels as high as 12 % [29].

Case history 3: COHb does not always correlate well with symptoms [30]

After travelling in a poorly maintained family car for nearly an hour, one of the five passengers, a normally robust 6-year-old girl fell asleep and was sufficiently unresponsive to raise concern.

She was driven direct to a nearby pediatric emergency room where she was found to be flaccid and responded only to deep painful stimulation with a cry and sluggish opening of her eyes (Glasgow Coma Score 8).

Apart from this reduced level of consciousness, physical examination revealed no abnormalities and a presumptive diagnosis of carbon-monoxide poisoning was made. Within 15 minutes of starting 100 % oxygen therapy the girl was awake. COHb of blood sampled before therapy was 35 %.

After two hours of oxygen therapy, COHb was 7 % and the little girl was fully alert. (GCS 15).

Blood was also sampled for COHb from four other occupants of the car; two children aged two and seven years and two female adults. COHb of the two children was 33.6 % and 34.7 % and the adults had COHb of 10.4 % and 16.1 %. Both children were asymptomatic, one of the adults complained of slight headache and the other of light-headedness.

This case study demonstrates that simultaneous exposure to the same CO source does not necessarily result in the same measured level of COHb, and symptoms manifested by individuals exposed to the same CO source may be dissimilar, despite almost identical COHb results.

SUMMARY

It is difficult to establish a normal range for COHb because the amount of COHb in blood is crucially dependent on variable levels of environmental carbon-monoxide pollution.

Unequivocal increase in COHb indicates either a hemolytic process or more commonly carbon-monoxide poisoning. Increased COHb reduces tissue oxygenation but this is not the only mechanism of CO toxicity. Laboratory measurement of COHb is the only routinely available blood test for diagnosis of CO poisoning.

It provides useful though limited prognostic information in such cases.

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