DEATHS AND INJURIES DUE TO NON-FIRE EXPOSURE TO GASES

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Abstract

In 2009, 784 people died of unintentional injuries due to non-fire exposure to gases. Anoxia, which is injury involving oxygen deprivation, accounted for 33,600 injuries reported to hospital emergency rooms in 2012, including 16,800 with no fire involvement.

Keywords: Gas, carbon monoxide, anoxia, injury, death, statistics

Acknowledgements

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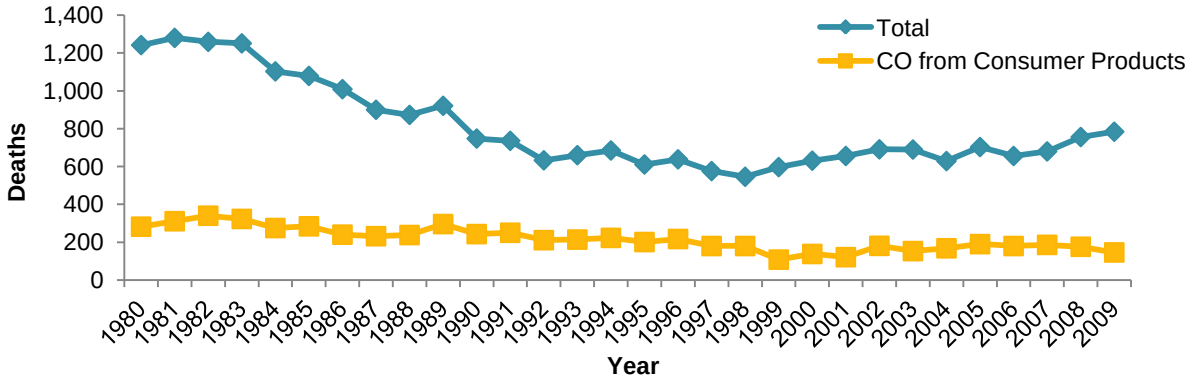
Deaths and Injuries Due to Non-Fire Exposure to Gases

In 2009, 784 people died of unintentional non-fire exposure to gases in the U.S.[1]
Most of these deaths are due to carbon monoxide. The last year when results were provided with enough detail to isolate carbon monoxide was 1998. In that year, motor vehicle exhaust, which is always carbon monoxide, accounted for 35% of total unintentional-injury deaths due to poisoning by gases and vapors. (See Table 1.) Another 33% involved unvented carbon monoxide from consumer products such as home heating or cooking equipment.[2]

Statistics are based on the national death certificate database. External cause codes X46-X47 are for unintentional injury deaths due to gas exposure, while codes X66-X67 are for deaths due to intentional injury to self using gas.

From 1980 to 2009, total non-fire unintentional deaths due to gas or vapor poisoning declined by 37%. (See Figure 1.) Of those deaths, the ones involving carbon monoxide and consumer products declined by 48%. Deaths involving motor vehicle exhaust gas have not been reported separately since 1998, but they had already declined sharply, by 68%, from 1982 to 1998.

Figure 1. Non-Fire Unintentional-Injury Deaths Due to Poisoning, by Gases or Vapors, 1980-2009



Since 1998, the only gases reported separately have been organic solvents and halogenated hydrocarbons, the products involved in drug abuse involving inhalants. In 2006, 71 of the 656 unintentional injury deaths due to non-fire exposure to gas involved organic solvents or halogenated hydrocarbons. This was 11% of the total, typical of the percentages seen since these injuries began to be reported separately in 1999. Statistics with these details were not available after 2006 for inclusion in this report.

For more information on fire department emergency responses to cases of non-fire carbon monoxide exposure, see Ben Evarts, *Non-Fire Carbon Monoxide Incidents*, National Fire Protection Association, Quincy, MA, March 2012.

[1] National Safety Council, *Accident Facts* and *Injury Facts*, 1981-2013 editions, 1121 Spring Lake Drive, Itasca, IL 60143.

[2] Matthew V. Hnatov, *Non-fire carbon monoxide deaths associated with the use of consumer products*, U.S. Consumer Product Safety Commission, Bethesda, MD, December 2012, and previous reports in series, assessed at www.cpsc.gov.

Table 1.
Non-Fire Unintentional-Injury Deaths Due to Poisoning by Gases and Vapors

Year	Total	Gas From Pipeline	Motor Vehicle Exhaust Gas	Other Utility Gas or Carbon Monoxide	Other	Estimated Carbon Monoxide Poisoning Involving Consumer Products*
1980	1,242	-	-	-	-	282
1981	1,280	-	-	-	-	311
1982	1,259	72	596	426	165	340
1983	1,251	82	580	414	175	323
1984	1,103	48	511	354	190	275
1985	1,079	49	4 88	392	150	284
1986	1,009	29	475	341	164	240
1987	900	53	402	288	157	232
1988	873	36	372	314	151	238
1989	921	48	355	353	165	296
1990	748	33	293	289	133	243
1991	736	20	278	316	122	250
1992	633	21	223	281	108	211
1993	660	14	245	290	111	214
1994	685	24	246	307	108	223
1995	611	27	234	272	78	201
1996	638	23	219	283	113	217
1997	576	13	208	251	104	180
1998	546	15	190	254	87	180
1999	597	-	-	-	-	108
2000	631	-	-	-	-	138
2001	656	-	-	-	-	121
2002	691	-	-	-	-	181
2003	690	-	-	-	-	153
2004	629	-	-	-	-	168

Table 1.
Non-Fire Unintentional-Injury Deaths Due to Poisoning by Gases and Vapors
(Continued)

Year	Total	Gas From Pipeline	Motor Vehicle Exhaust Gas	Other Utility Gas or Carbon Monoxide	Other	Estimated Carbon Monoxide Poisoning Involving Consumer Products*
2005	703	-	-	-	-	190
2006	656	-	-	-	-	180
2007	680	-	-	-	-	186
2008	756	-	-	-	-	176
2009	784	-	-	-	-	146**

* Consumer products are fuel-burning appliances used in or around the home.

** Estimates may change due to late data.

Note: Detailed breakdowns were not provided prior to 1982 or after 1998. The last column has estimates from the U.S. Consumer Product Safety Commission.

Source: National Safety Council, *Accident Facts* and *Injury Facts*, 1981-2013 editions, 1121 Spring Lake Drive, Itasca, IL 60143; http://www.cdc.gov/nchs, which is the website of the National Center for Health Statistics, which maintains the death certificate data base; Matthew V. Hnatov, *Non-fire carbon monoxide deaths associated with the use of consumer products*, U.S. Consumer Product Safety Commission, Bethesda, MD, December 2012, and previous reports in the series; http://www.cpsc.gov. Coding for the national death certificate database was substantially revised in 1999, changing the categories that can be used to analyze trends in deaths involving gases.

In 2009, 65 people died of non-fire injuries from unvented carbon monoxide from generators.

The death toll from carbon monoxide produced by generators increased sharply in the beginning of the 21st century, from less than 10 per year on average in 1999 and prior years to a peak of 87 per year in 2005-2006. The death toll was 65 in 2009. In the peak years, carbon monoxide deaths involving generators accounted for nearly half (47%) of all carbon monoxide deaths involving consumer products. The generator share was 45% in 2009.

The large jump in deaths involving generators in 2000 may reflect the fact that roughly half the total generators in use in 2000 had been purchased in 1999 because of concerns over Y2K (year 2000) problems with the nation's power grid.[3] It is likely that many of these new generator users had no experience in safe generator use. Disasters like Hurricane Katrina and a series of Florida hurricanes have added to the demand for generators and probably added to the number of inexperienced users.

The U.S. Consumer Product Safety Commission examined the circumstances of the 695 non-fire carbon monoxide generator deaths in 1999-2011.[4]

For one-third (227 or 36%) of the 633 deaths where it was known why generators were in use, the reason for use was power outage due to either weather, preparations for an anticipated storm, or problems with power distribution. Of the 201 deaths specifically because of a weather-related power outage and involving a known type of weather, 52% involved snow or ice storms and 31% involved hurricanes or tropical storms. Thunderstorms (6%), wind storms (5%), tornadoes (2%), and unspecified storms (3%) accounted for the other deaths.

The other leading reasons for generator use were power shutoff by electric company due to bill dispute or no n-payment (23% of deaths where a reason was reported); providing power to a storage shed, trailer, boat, camper, cabin, or campsite (18%); new home or homeowner with power not yet turned on or turned off for construction or renovation (13%); and providing power to a home or other structure that normally does not have electricity (8%). Miscellaneous other reasons accounted for 3% of the deaths.

The risk of death from carbon monoxide poisoning associated with generators is much greater in a temporary shelter than in any kind of home.

Homes (including multi-family) accounted for 74% of non-fire carbon monoxide poisoning deaths associated with generators after allocation of incidents with unknown location, compared to 12% for temporary shelters, such as tents and recreational vehicles. (Of the other 14%, 7% were in structures associated with a home but external to it such as a detached garage or shed, 5% were in vehicles, including vehicles used as homes, such as travel trailers and houseboats, and 2% were in other properties.) Because the population n in homes exceeds the population in temporary shelters by much more than the 7.2-to-1 ratio seen for deaths, it can be stated with confidence that the risk is much higher in temporary shelters.

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[3] *Portable generators,* U.S. Consumer Product Safety Commission, May 20, 2004, accessed at www.cpsc.gov.

[4] Matthew V. Hnatov, *Incidents, deaths and in-depth investigations associated with non-fire carbon monoxide from engine driven generators and other engine-driven tools, 1999-2011,* memorandum, U.S. Consumer Product Safety Commission, July 2012, accessed at www.cpsc.gov.

Carbon monoxide alarms can provide an early warning to occupants when carbon monoxide is present at dangerous levels.
NFPA 720: Standard for the Installation of Carbon Monoxide (CO) detection and warning Equipment (www.nfpa.org/720) is useful for those interested in learning more about this technology and its application.

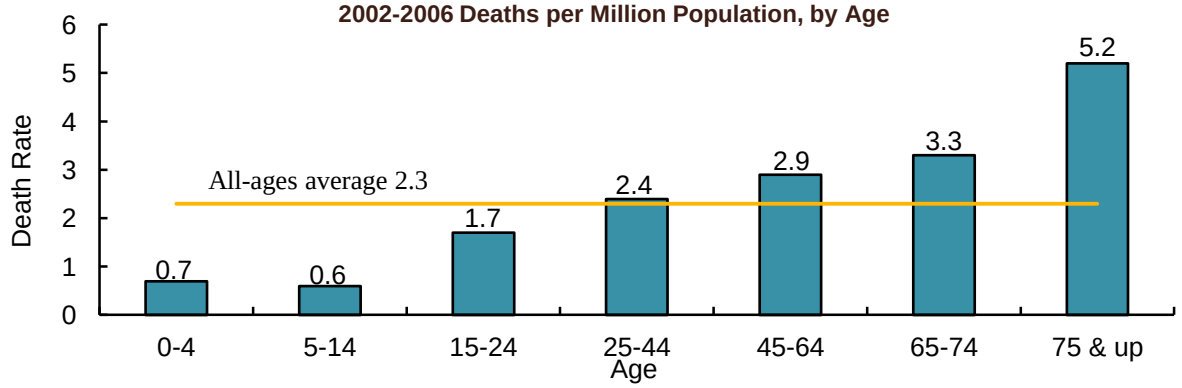
In the July 2012 Hnatov study cited earlier, almost none of the 310 deaths where the presence or absence of a carbon monoxide alarm was known (23, or 7%) showed a carbon monoxide alarm present. In 16 of the 18 cases where a carbon monoxide alarm was present and it was known whether it operated, the carbon monoxide alarm did not operate, usually (14 cases) because of a lack of battery power (7 cases) or a lack of power to a plug-in unit (7 cases).

The absence of carbon monoxide alarms from nearly all of these fatal carbon monoxide incidents may point to the effectiveness of carbon monoxide alarms, because homes in general were much more likely to have carbon monoxide alarms than homes with carbon monoxide fatalities apparently were. Statistics are available for 2007 and 2009 on the percentage of occupied housing units with (what are reported as working) carbon monoxide alarms – 32.6% in 2007 and 36.4% in 2009. From 2007 to 2009, the percentage rose by 3.8 percentage points or 1.9 percentage points a year. If you project that rate of increase backwards, than the percentage in 1999 would still have been above 15%, which would make the average percentage for 1999-2011 much higher than the 7% of homes with fatal carbon monoxide incidents that had carbon monoxide alarms.

Suicide deaths by gas (principally carbon monoxide) are about twice as numerous as unintentional injury deaths due to gas.[5]
In 2006, there were 1,408 suicide deaths by gas compared to the 656 unintentional injury deaths due to exposure to gas. By comparison there were 21 homicide deaths by gas and 104 deaths by gas with unknown intent. These were the latest figures available at press time.

Older adults are a high-risk age group for fatal injury from unintentional non-fire exposure to gases and vapors, but children are not. See Figure 2.

Figure 2. Non-Fire Deaths Due to Unintentional Poisoning by Gases and Vapors 2002-2006 Deaths per Million Population, by Age



Note: Rates based on 2004 resident population; latest published data by cause of death and age group is for 2006.
Source: http://www.cdc.gov/nchs/mortality_tables.htm,

[5] http://www.cdc.gov/nchs/data/mortfinal2006_workip2t4.pdf, National Center for Health Statistics, statistics from the death certificate data base.

Anoxia, which is injury involving oxygen deprivation, accounted for 16,800 injuries reported to hospital emergency rooms without fire involvement in 2012.
Anoxia can occur as a result of smoke inhalation (principally carbon monoxide) in a fire or as a result of other circumstances where oxygen is displaced by other gases, most of which would also qualify as poisonings by the other gases. It is not clear whether some, most, all, or none of the carbon monoxide poisoning injuries would also appear as anoxia injuries. See Table 2.

The percentage of anoxia injuries reported to hospital emergency rooms involving fire varies considerably from year to year, from just under half to well over half.

Table 2.
Anoxia Injuries Reported to
Hospital Emergency Rooms, With and Without Fire Involvement

Year	Total Anoxia Injuries	With Fire Involvement	Percent With Fire Involvement	Excluding Fire Involvement
1997	31,400	19,900	63%	11,500
1998	27,000	17,300	64%	9,700
1999	30,100	16,700	55%	13,500
2000	36,700	19,800	54%	16,900
2001	36,200	16,900	47%	19,300
2002	30,700	14,500	47%	16,100
2003	36,000	17,700	49%	18,300
2004	35,000	15,600	44%	19,400
2005	34,400	18,600	54%	15,800
2006	33,500	16,500	49%	17,000
2007	34,300	16,500	48%	17,900
2008	36,600	21,300	58%	15,300
2009	31,000	14,100	45%	16,900
2010	41,200	21,200	52%	20,000
2011	42,700	20,900	49%	21,800
2012	33,600	16,700	50%	16,800

Notes: These are projections from a sample of U.S. hospital emergency rooms. The sample was last modified in 1997, which means this is the earliest year for which the published data on injuries can be treated as comparable between years. However, there have also been multiple modifications since 1997 in the scope of data collection, including the addition of all or some injuries not involving consumer products.

Source: National Electronic Injury Surveillance System (NEISS), queried on http://www.cpsc.gov.

An average of 6,800 carbon monoxide exposures per year were self-reported to poison control centers in 2000-2009.[6]

The trend in exposures was fairly level from 2000 to 2006 and then down since then. Rates of exposure were highest for children under 18 years of age (26 per million population) and lowest for older adults age 65 or older (6 per million population). Exposure rates were higher for females (23 per million population) than for males (21). Exposure rates were higher in the Midwest (30 per million population) and Northeast (29) than in the West (20) and South (17).

Just over half the exposures were transported to a health care facility; the rest were managed on-site. Most exposures had minor or no effect on health. (See Table 3.) Most exposures presented with symptoms of headache, nausea, and/or dizziness. (See Table 4.)

Table 3. Health outcomes for people self-reporting carbon monoxide exposure to a poison control center, 2000-2009

Outcome	All exposures		Treated at health-care facility		Managed on-site	
No effect	22,500	(33%)	5,700	(8%)	16,900	(25%)
Minor effect	34,200	(50%)	21,600	(32%)	12,600	(18%)
Moderate effect	10,300	(15%)	8,700	(13%)	1,600	(2%)
Major effect	1,000	(2%)	1,000	(1%)	0	(0%)
Death	200	(0%)	100	(0%)	100	(0%)
Total	68,300	(100%)	37,100	(54%)	31,200	(46%)

Note: Percentages are based on all exposures. Exposures are rounded to the nearest hundred.

Source: CDC analysis of data from poison control centers, 2000-2009.

[6] A. Bronstein, J.H. Clover, S. Iqbal, F.Y. Yip, C.A. Martin, A. Chang, A.F. Wolkin, and J. Bell, "Carbon monoxide exposures – United States, 2000-2009," *Morbidity and Mortality Weekly Report*, Centers for Disease Control and Prevention, August 5, 20ll, Volume 60, pp. 1014-1017, http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6030a2.htm

Table 4. Symptoms for people self-reporting carbon monoxide exposure to a poison control center, 2000-2009

Symptom	All exposures		Treated at health-care facility		Managed on-site	
Headache	30,800	(45%)	21,000	(57%)	9,800	(32%)
Nausea	17,700	(26%)	12,500	(34%)	5,100	(16%)
Dizziness or vertigo	13,400	(20%)	9,600	(26%)	3,800	(12%)
Drowsiness or lethargy	9,000	(13%)	6,100	(16%)	2,900	(9%)
Vomiting	7,500	(11%)	5,900	(16%)	1,600	(5%)
Confusion	2,100	(3%)	1,800	(5%)	300	(1%)
Synocope (loss of consciousness)	1,900	(3%)	1,800	(5%)	100	(0%)
Dyspnea (shortness of breath)	1,500	(2%)	1,200	(3%)	300	(1%)
Chest pain (cardiac or non-cardiac)	1,200	(2%)	1,100	(3%)	200	(1%)
Other	6,500	(10%)	4,800	(13%)	1,800	(6%)
No symptoms reported	21,800	(32%)	5,300	(14%)	16,500	(53%)
Total	68,300	(100%)	36,700	100%)	30,800	(100%)
Total symptoms	113,500	(166%)	71,100	(192%)	42,400	(136%)

Note: Exposures can have multiple symptoms and are rounded to the nearest hundred. Percentages are based on column totals. Exposures with unknown treatment (on-site vs. healthcare facility) have been proportionally allocated.

Source: CDC analysis of data from poison control centers, 2000-2009.

Data Sources and Methodology

The national death certificate database, maintained by the U.S. National Center for Health Statistics (NCHS), is coded according to the International Classification of Diseases (ICD), which was substantially revised in 1999. These modifications changed the categories that can be used to analyze trends in deaths involving gases.

The U.S. Consumer Product Safety Commission (CPSC) maintains the National Electronic Injury Surveillance system (NEISS), which provides sample-based estimates of injuries reported to hospital emergency rooms.