U.S. Department of Transportation
National Highway Traffic Safety Administration

DATA COLLECTION STUDY: DEATHS AND INJURIES RESULTING FROM CERTAIN NON-TRAFFIC AND NON-CRASH EVENTS

May 2004

- **Vehicle-Generated Carbon Monoxide**
- **Vehicle Backing**
- **Vehicle Heat (Weather Induced)**
- **Power Windows**

A Continuation of the Study of Non-Traffic and Non-Crash Motor Vehicle-Related Safety Issues Focusing on 1998 Death Certificates and Other Sources Containing Relevant Data and Information

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I. Executive Summary

This report presents results of a study to determine the extent of certain selected non-traffic or non-crash motor vehicle-related hazards, and the relative value of various sources for providing the National Highway Traffic Safety Administration (NHTSA) with information on those hazards. This investigation was conducted as a result of safety issues that have been raised concerning potential non-traffic and non-crash safety problems.

NHTSA's Office of Rulemaking, with assistance from the National Center for Health Statistics (NCHS), conducted a study of selected death certificates. Although NHTSA has an extensive database of statistical information on motor vehicle crashes that occur on the public traffic way, the agency does not have a database or other means to adequately determine the number of motor vehicle-related deaths that involve a motor vehicle in certain non-traffic or non-crash situations.

The data included in this report continues work begun following the deaths of 11 children from heat exposure in three incidents of accidental trunk entrapment in a one-month period of the summer of 1998. That study of 1997 death certificates found that death certificates represent a good source for identifying non-traffic and non-crash motor vehicle-related deaths. A final report of that study was published on May 6, 2002 and is in NHTSA Docket No. 1999-5063.

The data in this report examines 1998 death certificates and other sources of information relating to the following four hazards:

1. Persons left in a vehicle's passenger compartment or who lock themselves in the trunk of a vehicle in hot weather,
2. Children strangled by a vehicle's power window or sunroof,
3. Persons killed or injured as a result of a vehicle backing up, and
4. Persons killed or injured as a result of vehicle-generated carbon monoxide.

Only issues #1 and #2 above were examined in the study of 1997 death certificates referenced above.

This report is based on 4,046 death certificates from 1998, received from 35 states and the District of Columbia, out of an identified sample of an estimated 5,500 cases. The cases were derived from the most recent NCHS death certificate data that was available when this study was conducted. National estimates were extrapolated from this sample based on a simple ratio of identified cases to cases for which death certificates were received.

This study also examined a number of databases and other data sources, both within NHTSA and outside the agency, as well as peer reviewed research articles.

The results of the study are summarized below.

- *Carbon monoxide* - Unintentional deaths from vehicle-generated carbon monoxide found in 1998 death certificates project to a national total of slightly less than 200 such deaths a year. This is consistent with other sources examined. These deaths often involve adults who are in or around running vehicles in closed garages or in their homes having forgotten to turn off a vehicle in an attached garage. Victims in some of the cases identified were under the influence of alcohol at the time of their death.
- *Vehicles backing up* - Deaths found in 1998 death certificates project to a national total of about 120 deaths annually of persons struck by a vehicle backing up. Most of the victims

are either very young (less than five years old) or elderly (60 and above), with most of the elderly victims over age 70. As many as 6,000 injuries occur each year as a result of vehicles backing into a person, but these injuries are almost all very minor.

- *Excessive heat inside a vehicle passenger compartment* - Deaths found in 1998 death certificates project to a national total of 29 deaths annually of persons exposed to excessive heat inside a vehicle passenger compartment. A similar level of annual deaths (27) from this cause was found in the agency's study of 1997 death certificates when a national projection was made.
- *Vehicle window* - Four deaths resulting from interaction with a vehicle window were found in 1998 death certificates. The study of 1997 death certificates also found four deaths involving interaction with a vehicle window.

II. Background

NHTSA is responsible for reducing deaths and injuries associated with motor vehicles. The agency, in its Fatality Analysis Reporting System (FARS), collects detailed data from states that produce an actual count of fatalities resulting from traffic crashes. The agency also gathers a national sample of police reported traffic crashes through the National Automotive Sampling System (NASS) General Estimates System (GES).

NHTSA is also responsible for motor vehicle safety when there is not a crash or the event occurs off the public traffic way. When the agency tries to quantify safety problems associated with non-traffic or non-crash situations it often finds that it has little or no data and must rely on the data gathering efforts of others. While providing interesting and useful information, the data available from others usually provide insufficient detail to guide NHTSA as to whether or not a regulatory or some other response is needed and, if so, what that response should be. Issues arising in this area therefore sometimes require ad hoc information-gathering efforts.

Such was the case in the summer of 1998 when in three separate incidents 11 children died from excessive heat after accidentally locking themselves in vehicle trunks. In January 1999, the agency assembled a panel of experts composed of industry, safety advocates, medical experts, law enforcement, and other relevant groups to address the non-traffic non-crash safety issue of trunks that cannot be opened from the inside should someone accidentally or through criminal intent become trapped inside. In June 1999, this panel recommended that NHTSA "should establish a national data system designed to measure the frequency and consequences of trunk entrapment." On October 20, 2000, NHTSA published a Final Rule in the Federal Register establishing a new Federal Motor Vehicle Safety Standard, (FMVSS) No. 401: Internal Trunk Release, that requires all new passenger cars with trunks to be equipped with a release latch inside the trunk compartment beginning September 1, 2001.

In March 2000, the agency also initiated a study of selected 1997 death certificates to determine the utility of death certificates in identifying deaths resulting from certain non-traffic or non-crash motor vehicle-related situations. That study focused on the following three issues:

1. children who die as a result of being left unattended in a motor vehicle's passenger compartment in hot weather or who die after locking themselves in the trunk of a vehicle,
2. kidnap victims who die as a result of being locked in the trunk of a vehicle, and
3. children strangled by motor vehicle power window.

A report on this study of 1997 death certificates was published on May 6, 2002 and is in NHTSA Docket No. 1999-5063-286.

NHTSA's Office of Rulemaking conducted additional research to expand the work begun in the study of 1997 death certificates. The research involved an examination of selected 1998 death certificates. Other sources, including several databases and a number of academic research articles, were also examined. Invaluable assistance and guidance concerning the death certificate research involved was provided by the National Center for Health Statistics (NCHS).

The hazards examined in this report include two from the study of 1997 death certificates – death from excessive heat in the passenger compartment or trunk of a vehicle and death resulting from a power window or sunroof –and two other hazards - death from vehicle-generated carbon monoxide and death as a result of being struck by a vehicle backing up. In

addition, this report examines the extent to which these non-traffic or non-crash hazards result in injuries.

The criteria used to identify deaths from excessive heat inside the passenger compartment of a vehicle are essentially the same as those used to identify heat related deaths inside a vehicle trunk.

The research methodology and results are reported on in the sections of the report that follow.

III. Methodology

NHTSA's study of 1997 death certificates was successful in locating a small number of certain types of non-traffic or non-crash motor vehicle-related deaths. That study also confirmed death certificates' value as a source for identifying non-traffic and non-crash motor vehicle-related deaths. There were inherent limitations of the data in the study 1997 death certificates, however. Although the criteria for selecting death certificates for review were carefully chosen, there was no way of knowing for certain whether or not all of the death certificates reflecting non-traffic or non-crash deaths had been identified and if not, what percentage of the total was represented by those found. Even among death certificates received, there were some that suggested that a non-traffic or non-crash incident was involved, but this could not be confirmed based on the information in the death certificate, and in some cases even after the appropriate coroner or other official was contacted. Finally, there was no way of knowing whether or not the number of incidents found for just one year was indicative of the ongoing magnitude and scope of a hazard or whether the snapshot of data from one year might be contradicted by data derived from another year or years, or from another source or sources.

In the broadest and simplest sense then, the methodology for the research reflected in this report was to collect whatever data was available on the non-traffic and non-crash motor vehicle-related hazards of interest from whatever sources were available. The sources in which relevant information was found for each of the issues are indicated below.

Carbon Monoxide:	death certificates, LexisNexis™, literature review
Backing:	death certificates, LexisNexis™, FARS, literature review, injury databases (NEISS and GES)
Vehicle Heat:	death certificates, LexisNexis™, literature review
Vehicle Window:	death certificates, LexisNexis™, literature review

The totals of non-traffic and non-crash motor vehicle-related incidents located in death certificates, LexisNexis™ and some of the other sources reviewed for this study represent simple counts of relevant incidents. While there were no hard and fast rules that applied to identifying relevant cases, incidents involving particularly unusual events were excluded from the counts. As an example, if a person were backed over by a vehicle that was left running, in reverse, and unattended, this case was excluded from the count of backing incidents.

The specific methodology that applied to each of the types of sources investigated is described below.

A. 1998 Death Certificates

State laws require death certificates to be completed for all deaths. Furthermore, federal law mandates national collection and publication of death and other vital statistics data. As a result, and as confirmed by the study of 1997 death certificates conducted by NHTSA, death certificates represent a reliable and comprehensive source of information regarding non-traffic and non-crash motor vehicle-related deaths, particularly if information is entered for all of the key elements of a death certificate and if the certificate includes at least some description of how the injury that resulted in death occurred.

As it did in researching 1997 death certificates, NHTSA's Office of Crash Avoidance Standards contacted and met with representatives of the NCHS to solicit their help in researching 1998 death certificates. NCHS publishes annual reports of all deaths in the United States using information derived from death certificates. Among other information, each death is assigned various codes that identify the disease or condition directly leading to death, antecedent causes, and other significant medical conditions involved.

For the year 1998, the underlying cause of death, and the other specific injuries, diseases, and conditions related to a death are classified and coded using the International Classification of Diseases, 9th Revision (ICD-9). ICD-9 is designed for the classification of morbidity and mortality information for statistical purposes, for the indexing of hospital records by disease and operations, and for data storage and retrieval. ICD-9 also contains a supplementary classification of external causes of injury (E-Codes) that permits the classification of environmental events, circumstances, and conditions as the cause of injury and other adverse effects.

NHTSA identified what it considered to be the ICD-9 codes, primarily E-Codes, most likely to be indicated on death certificates reflecting one of the non-traffic or non-crash motor vehicle issues included in this study. Clearly, not all deaths assigned ICD-9 codes suggestive of these conditions involve non-traffic or non-crash motor vehicle-related events. In addition, deaths of interest may have been coded, for various reasons, with codes other than those on which this research focused. However, deaths associated with the ICD-9 codes identified for this research represented a universe of deaths that would most likely contain deaths resulting from the non-traffic or non-crash injuries being studied.

In June of 2002, NHTSA met with NCHS officials to discuss NHTSA's review of the public use Multiple Cause of Death (MCOD) data, the annual data file containing information derived from all U.S. death certificates, and how to proceed with the study of 1998 death certificates. It was agreed that the same protocol followed for the study of 1997 death certificates would be followed for purposes of obtaining 1998 death certificates. The seven steps of the protocol are:

(1) Submission of materials by NHTSA to NCHS reflecting the purpose of the study and how information on the death certificates would be used.
(2) Submission of NHTSA's materials to the National Association for Public Health Statistics and Information Systems' Executive Committee for review and approval.
(3) Assistance to NHTSA from NCHS in identifying the selection criteria from the information available in the electronic files with special attention paid to the injury codes.
(4) The submission by NCHS of a request to each state for permission to release the death certificate numbers to NHTSA in support of this study.
(5) Release of death certificate numbers to NHTSA by NCHS as states agreed to this.
(6) NHTSA's submission of a request to each state asking for copies of death certificates (by identifying number), including any applicable fee for the service. In the request, NHTSA stated that it would under no circumstances attempt to contact family members of the decedents. In some cases additional paperwork and state level approvals were required for research of this sort.
(7) NHTSA's review of death certificates, taking precautions to protect all information obtained from them. States consider both the death certificate numbers and the identifying information on the certificates to be confidential, and are sensitive to the risk of "identity theft."

Research involving death certificates necessarily creates a substantial gap between the year in which the deaths involved occurred and the time when the research is completed. This gap is largely the product of the time it takes for NCHS to receive and assemble data from the states and finalize its annual MCOD file. Typically, the most recently completed MCOD file is two years or more older than the year in which it becomes publicly available. In addition, considerable time is required to complete the process described above. Some states add another step to this process by requiring detailed paperwork and state review board approvals, which are above and beyond the initial approvals required to obtain death certificate numbers.

NHTSA initiated and followed the recommended protocol. NCHS staff reviewed a NHTSA suggested list of selection criteria for the non-traffic and non-crash motor vehicle issues to be studied and proposed some additional selection criteria. Table I provides the E-Codes, code descriptions, associated issues and any other data filters that were used in identifying the more than 15,000 death certificates of initial interest to the study.

Table I: E-Codes Used in Locating Death Certificates
For Use in National Highway Traffic Safety Administration Research of
Non-Traffic and Non-Crash Deaths in 1998

Issues:

1. Children left in a vehicle's passenger compartment in hot weather or who lock themselves in the trunk of a vehicle, **(Vehicle heat/trunk)**
2. Children strangled by a vehicle's power window or sunroof, **(Vehicle window)**
3. Persons killed or injured as a result of a vehicle backing up, **(Backing)** and
4. Persons killed or injured as a result of vehicle-generated carbon monoxide. **(CO)**

E-Code	Description	Issue	Ncode Limits	
814	Motor vehicle traffic accident involving collision with pedestrian	Backing		
817	Noncollision motor vehicle traffic accident while boarding or alighting	↓		
818	Other noncollision motor vehicle traffic accident	↓		
819	Motor vehicle traffic accident of unspecified nature	↓		
822.7	Other motor vehicle nontraffic accident involving collision with moving object (pedestrian)	↓		
823.7	Other motor vehicle nontraffic accident involving collision with stationary object	↓		
824	Other motor vehicle nontraffic accident while boarding and alighting	↓		

E-Code	Description	Issue	Ncode Limits	
825.0	Other motor vehicle nontraffic accident			
825.1	of other and unspecified nature	↓		
825.6				
825.7		↓		
825.8				
825.9		↓		
		↓		
868.2	Accidental poisoning by other utility gas and other carbon monoxide – motor vehicle exhaust gas	CO		
900	Excessive heat – due to weather conditions	Vehicle heat/ trunk		
913.2	Due to lack of air (in closed place)	Vehicle heat/ trunk		
913.8	Accidental mechanical suffocation – Other specified means	Vehicle window		Less than 9 years old
913.9	Accidental mechanical suffocation – unspecified means	↓ ↓		Less than 9 years old
918	Caught accidentally in or between objects	↓		Less than 9 years old
962.2	Assault by poisoning – other gases and vapors	CO	Only records also with N986	
968.4	Criminal neglect	Vehicle heat/ trunk & CO	Only if N986 or N992 is also present	
982.0	Poisoning by other gases, undetermined whether accidentally or purposely inflicted – motor vehicle exhaust gas	CO		
983.0	Hanging, strangulation, or suffocation, undetermined whether accidentally or purposely inflicted	Vehicle window		
983.8	Hanging, strangulation, or suffocation, undetermined whether accidentally or purposely inflicted – Other specified means	↓ ↓ ↓ ↓		
983.9	Hanging, strangulation, or suffocation, undetermined whether accidentally or purposely inflicted – Unspecified means	↓ ↓ ↓ ↓		

E-Code	Description	Issue	Ncode Limits	
988.8	Injury by other specified means, undetermined intent	All		

Code		
986	Toxic effect of carbon monoxide	For use in selected circumstances (noted above) in combination with an E-Code
992	Effects of heat and light	For use in selected circumstances (noted above) in combination with an E-Code

The MCOD file includes a variable for the "Underlying Cause of Death" and variables for up to 20 injuries or diseases that may have contributed to the death. In the language of the MCOD file, these are called "Record Axis Conditions." NHTSA expected that deaths caused by non-traffic and non-crash motor vehicle-related injuries would be a subset of those with codes for the underlying cause of death, but records were also examined according to the 20 record axis conditions. In addition to searching the underlying cause of death and other conditions using the ICD-9 codes in Table I, certain data filters, also reflected in Table I, were imposed. A search of 1998 death certificate data was limited to children less than 9 years of age for E-Code 913.8, 913.9 and 918. These E-Codes were intended to identify victims of strangulation by power window. The search using E-Code 962.2 was limited to those records also containing an N-Code (nature of injury code) of 986. Finally, for E-Code 968.4, the search was limited to those records also containing an N code of either 986 or 992.

Using the public use version of the MCOD file, NHTSA made some preliminary calculations as to the number of death certificates that might include people who died in a non-traffic or non-crash motor vehicle-related event. Depending on the E-Codes and other criteria used, it was determined that the number of death certificates that might reflect incidents of the type under study exceeded 15,000. In contrast, only 1,792 death certificates were identified as being of interest for the study of 1997 death certificates. The bulk of the increase in the 1998 death certificates resulted from the inclusion of backing incidents as an area of study. The E-Codes that were likely to reflect backing incidents were sufficiently broadly defined that it was clear they included a wide range of other, more common motor vehicle crashes as well.

At an average price per death certificate on the order of $8 to $9, it was strongly felt, and budgetary constraints required, that every effort be made to minimize the number of death certificates that ultimately would be requested from the 50 states, the District of Columbia and New York City.

A large percentage of the deaths included in this number were likely from conventional traffic crashes because the E-Codes 814-825 are used in death certificates for a wide spectrum of motor vehicle crashes. For example, "E-Code 822.7 – Other motor vehicle non-traffic accident involving collision with moving object (pedestrian)" – would apply to non-traffic vehicle and pedestrian accidents in which a vehicle was moving either forward or backward. Those involving the forward motion of a vehicle were not part of this study.

NHTSA representatives on several occasions discussed with NCHS representatives possible ways of reducing the number of death certificates to be obtained. The focus of those discussions was on how to eliminate from the death certificates that would be requested from the states those that would clearly not be of interest to this study because they resulted from traffic

crashes that did not involve backing. In most cases, motor vehicle-related deaths from the MCOD file that were initially identified as being of possible interest to the study would actually not be of interest if they were also contained in FARS because the vast majority of deaths in FARS do not involve backing.

Combining the electronic version of the MCOD file with other data is not permitted by NCHS. So that NHTSA could eliminate deaths identified in the NCHS MCOD file that were clearly the result of crashes that did not involve backing, the Office of Rulemaking printed out some basic data from this death certificate file. Death certificate numbers were not in the file used and therefore were not included in the data printout. The Office of Rulemaking also printed out some basic data from the more than 40,000 deaths contained in FARS for 1998. Using these printouts, data were manually compared and, as a result, a large number of deaths from the list of death certificates of interest were eliminated. Most deaths in the MCOD file that also appeared to be in FARS were eliminated from further consideration. However, if FARS data indicated that the crash involved a pedestrian and the first point of impact was the rear of the vehicle, these deaths were included in those for which death certificates were requested since a backing incident relevant to the study was strongly suggested. Some deaths were retained among those of interest, particularly if a pedestrian was involved, even though there was no data to suggest a backing incident was involved. The researchers wanted to eliminate those deaths that clearly were not of interest, but also wanted to be sure to leave in those with even a remote possibility of being relevant.

Some states (a small number) were delayed in granting NCHS permission to allow NHTSA to receive death certificate numbers. As a result, some death certificates were not requested from some of the states in time for those certificates to be included in the data presented in this report. The exact number of death certificates that would have been requested from those states is not known. However, it was estimated that if all certificates of interest had been received from all of the jurisdictions, the total number of certificates would have been approximately 5,500. As of the date of this report, 4,729 death certificates have been requested from 44 states and the District of Columbia.

Counts of incidents of any type from death certificates represent a floor as to the number of incidents that actually occurred. Deaths of interest may not have been coded according to the selection criteria chosen. Also, death certificates are often very sketchy in the descriptive information they provide. Limited follow up with medical examiner's and other offices thus far has uncovered backing incidents, for example, that were not clearly identifiable from death certificates alone. In some cases, information on a death certificate strongly suggests it is an incident of interest, but the medical examiner's office and even the police agency involved were unable to clarify the situation.

Not all death certificates requested have been received, nor is it anticipated that death certificates from every jurisdiction will be received. As of the writing of this report, NHTSA has received and reviewed 4,046 death certificates from 36 jurisdictions, 35 states and the District of Columbia. Data from these death certificates, excluding personal identifiers and certificate numbers, has been entered into a database.

The 36 jurisdictions that provided death certificates for this study represent a good cross section of states. They reflect a balanced mix of characteristics, such as urban and rural, cold climate and warm climate, and geographic regions of the country.

Straight-line projections of anticipated national totals are made in this report using the number of deaths found in 1998 death certificates. A simple ratio was used to account for the

missing death certificates. The ratio was determined from the number of certificates selected and received (5,500/4,046=1.36).

The researchers believe that projections from the available data are reasonable estimates and reflect the magnitude and scope of the hazards studied because of the balanced mix of the states that provided death certificates. Had those states been skewed toward warmer climates, for example, this might have had an effect on the projected national totals of vehicle-related carbon monoxide deaths since these incidents tend to happen in colder climates during the winter months.

B. LexisNexis™

To support this research, NHTSA subscribed to LexisNexis™ so that it could search for news articles related to the four types of motor vehicle-related hazards under study. A variety of words and phrases likely to be associated with these hazards were used to conduct searches of LexisNexis™.

LexisNexis™ served several purposes. When a death certificate was suggestive of a type of incident under study, but not conclusive, an article in LexisNexis™ sometimes confirmed the nature of the incident so that it could be included or excluded from this study. Sometimes, articles in LexisNexis™ identified incidents from 1998 that were not located in 1998 death certificates. Also, LexisNexis™ identified incidents from years beyond 1998.

References to LexisNexis™ derived data or information appear in various contexts in the data and information presented in this report. In the case of some death certificates, an article found in LexisNexis™ either confirmed the nature of the incident or provided additional information concerning that incident. In such cases, this is indicated. A count of the incidents that have occurred in the five completed calendar years, 1998-2002, and that were located in LexisNexis™ is presented in this report. For the year 1998, the number of LexisNexis™ identified deaths that were also found in death certificates is indicated. For the years 1999-2002, data presented are derived solely from LexisNexis™.

It should be emphasized again here that the cases identified through LexisNexis™ only represent a count of cases. It is very clear from experience with LexisNexis™ that many cases of interest to this research are either not reported in news outlets or not included in LexisNexis™ because the news outlets in which such cases might be reported are not included in the universe of outlets from which LexisNexis™ draws.

Unlike either death certificates or FARS, as described immediately following, articles found in LexisNexis™ report on both deaths and injuries. Therefore, LexisNexis™ derived data presented in this report include injuries.

C. Fatality Analysis Reporting System

NHTSA's Fatality Analysis Reporting System (FARS) focuses on fatalities from vehicle crashes that occur on public roads. FARS is a count of the annual national total of fatalities resulting from vehicle crashes on public roadways. FARS represented a potential source of backing incidents since backing incidents may occur off-road or on a public road.

Among the various bits of data noted and entered into the FARS database is the point on the vehicle at which the first impact relating to the incident occurred. An examination of FARS data relating to pedestrian fatalities that occurred in 1998 identified a number of incidents in which a pedestrian was first struck by the rear of the vehicle involved. In other words, cases

were identified in FARS with a high probability of being backing incidents of the sort of interest to this research.

As described previously, this was helpful in being sure to select for review certain 1998 death certificates whose data matched a FARS record in which the rear of the vehicle was the first point of impact. It also demonstrated that FARS contains backing incidents of the sort under study.

Since backing incidents were found in FARS for 1998, FARS data was examined to identify potentially relevant backing incidents that occurred in years later than 1998. FARS is created from data that are derived from Police Accident Reports (PARs) that are reviewed to identify deaths from vehicle crashes that are appropriate to include in FARS. The rules governing FARS require that PARs from the two most recently completed calendar years plus the current year be retained. Older PARs are typically destroyed. FARS data was examined for possible backing incidents in late 2002. At that time, the years for which PARs were still available were 2000 and 2001.

A search of FARS data for the years 2000 and 2001 located 91 apparent backing fatalities in 2000 and 67 in 2001. States were requested to provide the PARs for these incidents. A total of 138 for the two years were received. Thirty-six of the incidents reflected in the PARs received and reviewed were not entered into the NHTSA database of non-traffic and non-crash cases because they involved situations outside the scope of the research, such as an incident involving an unusual vehicle like a small front end loader. A few of the 36 were not entered because either the quality of the photocopy or the limited information provided was such that what exactly happened could not be determined.

Fourteen (14) backing deaths identified in FARS had been previously identified through other sources, usually LexisNexis™. The remaining 88 deaths had not been found in other sources. Even though FARS focuses on deaths from vehicle crashes that occur on public roads, many of the backing incidents in FARS occurred in driveways or other off-road locations similar to those found in 1998 death certificates and in other sources. These incidents may have been included in FARS because the circumstances were ambiguous as to exactly where the incident took place or they ultimately involved a public roadway in that the vehicle and/or the victim ended up in a public roadway.

D. Peer-Reviewed Scientific, Medical and Public Health Journals

A review of scientific, medical and public health research literature dealing with the issues being investigated was begun using PubMed, an on-line service of the National Library of Medicine that provides access to the library's MEDLINE. MEDLINE contains more than 12 million life science and public health article citations dating back to the mid-1960's. In most cases, only abstracts are provided so several trips to the National Library of Medicine in Bethesda, MD were made to examine and, when necessary and appropriate, make copies of full articles relevant to the issues covered in this report.

E. The National Electronic Injury Surveillance System (NEISS)

For nearly 30 years, the U.S. Consumer Product Safety Commission (CPSC) has operated this statistically valid injury surveillance and follow-back system. The primary purpose of NEISS has been to provide timely data on consumer product-related injuries occurring in the U.S. Beginning in 2000, NEISS was expanded to collect data on all injuries, including those involving a motor vehicle. Collection of information on this more broadly defined universe of injuries began as of July 1, 2000. NEISS provided valuable information on backing injuries.

NEISS injury data are gathered from the emergency departments of 100 hospitals. These hospitals are selected as a probability sample of all 5,300+ U.S. hospitals with emergency departments. A "trauma weight" is determined for each case in NEISS. According to the CPSC, when there are 20 or more cases of a particular type of incident, one may add the trauma weights for those incidents to come up with a projection as to the number of such incidents that occur nationally in a given year. When there are fewer than 20 incidents of a given type, the CPSC indicates that the national projections that one derives from these trauma weights are less reliable statistically.

As part of this round of research, NHTSA obtained finalized NEISS data for the last six months of 2000 and preliminary, although close to finalized data for the first six months of 2001. This was the most recent data available when this research was conducted.

This year's worth of NEISS data was searched for young children who were left in a hot vehicle, trapped in a trunk, or caught by a power window. It was also searched for backing incidents. Backing was the only area in which multiple cases of injuries were found.

A total of 265 possible backing incidents were located in NEISS. The text fields in each record were reviewed to determine which of the incidents actually involved incidents of the type under study.

F. NHTSA's General Estimates System (GES)

Data for the General Estimates Systems (GES) come from a nationally representative sample of police reported motor vehicle crashes of all types, from minor to fatal. The system began operation in 1988. It was created to identify traffic safety problem areas, provide a basis for regulatory and consumer initiatives, and support cost benefit analyses of traffic safety programs. The information is used to estimate how many motor vehicle crashes of different kinds take place, and what happens when they occur. Although various sources suggest that about half the motor vehicle crashes in the country are not reported to the police, the majority of these unreported crashes involve only minor property damage and no significant personal injury. By restricting attention to police-reported crashes, GES concentrates on those crashes of greatest concern to the highway safety community and the general public.

A search of GES data for the years 1996 to 2000, the most recent data available when the search was done, was conducted to identify GES records for which non-occupant impact was the first harmful event in the crash, with damage to the rear of the vehicle as the initial impact and with vehicle role and maneuver consistent with backing. Incidents were identified that allowed for national projections of backing incidents. There was no language describing what occurred in the incidents that could be reviewed. So the national projections may include backing incidents of a type, such as vehicle rollaways, that are outside the scope of this study.

G. Health Care Utilization Databases of the Centers for Disease Control and Prevention

Several databases related to health care utilization maintained by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention seemed like strong candidates for providing good information on the issues under study. They were not. Information derived from these databases applicable to the non-traffic and non-crash injuries considered for this report was extremely limited.

The CDC databases exist to measure large indicators of how health care resources in the United States are utilized, such as the extent to which health care resources are used by various age groups, the payers involved in obtaining health care, or the types of treatments, therapies and

drugs that are employed nationally. In short, the databases are aimed at big picture issues, not more narrow subjects such as non-traffic and non-crash motor vehicle-related safety issues that involve small numbers of occurrences annually.

The databases do offer a limited opportunity to identify incidents involving non-traffic and non-crash motor vehicle-related safety concerns and for getting a very generalized (non-statistical) sense of the relative magnitude of certain non-traffic and non-crash motor vehicle-related hazards. That opportunity exists in the text fields for each record in the databases. Unfortunately, information is not always entered in these text fields and the information that is entered is not always descriptive enough to determine exactly what happened to cause an injury. For example "MVA," referring to a motor vehicle accident, sometimes appears as the only thing entered in the text field of a record.

Unintentional injuries, which are how each of the types of incidents in this study would be characterized, are a subset of the data contained in each of the CDC databases. By searching the text fields of unintentional injuries in the databases for certain words likely to be used in describing an injury resulting from the issues under study, several relevant incidents were located. However, because the number of incidents found was so few, reliable national projections of the numbers of these types of incidents could not be made. The CDC databases generally require at least 30 incidents of a given type before statistically reliable national projections about the incident type can be made.

Each of the CDC databases examined is briefly described below.

1. National Ambulatory Medical Care Survey

The National Ambulatory Medical Care Survey (NMACS) is a national sample of patient visits to office-based physicians who are not employed through the federal government and who are primarily engaged in direct patient care. The survey, which includes specialists, is conducted annually. The opportunity to gain some insights into how an injury occurred is in a small text field on the survey form called "cause of injury."

The NAMCS determines a "patient visit weight" for each record in this database. This represents the projected total number of office visits that occurred across the country and that are similar to the particular record involved. The patient-visit weights for all of the records in the NAMCS sample indicate that there were a total of 823,541,999 physician office visits in the year 2000 involving physicians of the type included in the NAMCS. National projections for subcategories of office visits, by age group for example, may also be tallied with varying degrees of statistical confidence. If there are less than 30 records in any subgroup, national projections are considered less reliable statistically.

NHTSA examined the NAMCS data file for the calendar year 2000, the latest year for which survey results were available when research for this report was conducted. That file contains 27,369 records, of which 3,042 relate to an unintentional injury. Of the 3,042 unintentional injury records, 994 contained no text in the "cause of injury" field. A review of the 2,148 records with entries in the "cause of injury" field located one record of interest to this study. That was an incident in which the "cause of injury" was given as "mother backed car over child," in this case a three year old. With only one record of a backing incident identified, the "patient visit weight" of 3,983 for that incident was of little or no predictive value.

2. National Hospital Ambulatory Medical Care Survey

The National Hospital Ambulatory Medical Care Survey (NHAMCS) collects data on the utilization and provision of ambulatory care services in hospital emergency and outpatient

departments. Findings are based on a national sample of visits to the emergency and outpatient departments of non-institutional general and short-stay hospitals, exclusive of federal, military, and Veterans Administration hospitals, located in the 50 States and the District of Columbia. Annual data collection began in 1992.

As with the other CDC databases, the text fields of each record were searched to locate incidents of interest that are included in the database.

Emergency Departments

The 2000 NHAMCS file for emergency department visits contains 25,622 records, 8,791 of which are for unintentional injuries. The text fields of the unintentional injury records were searched for certain words that would likely be used in describing one of the types of non-traffic or non-crash motor vehicle-related incidents under study. A total of five incidents involving a vehicle backing up were found in the NHAMCS emergency department file. Details of those incidents are provided elsewhere in this report.

Outpatient Departments

The outpatient portion of the NHAMCS for the calendar year 2000 file has 27,510 records, 3,002 of which relate to an unintentional injury. As with the emergency department records, the text fields of the outpatient department unintentional injury records were searched for certain words that would likely be used in describing one of the types of non-traffic or non-crash motor vehicle-related incidents under study. No records of injuries reflecting the types of hazards under study were found in the search of this file.

3. National Hospital Discharge Survey

The National Hospital Discharge Survey (NHDS) has been conducted annually since 1965. It is a national probability survey designed to meet the need for information on characteristics of inpatients discharged from non-Federal short-stay hospitals in the United States. The NHDS collects data from a sample of approximately 270,000 inpatient records acquired from a national sample of about 500 hospitals. Only hospitals with an average length of stay of fewer than 30 days for all patients, general hospitals, or children's general hospitals are included in the survey. Federal, military, and Department of Veterans Affairs hospitals, as well as hospital units of institutions (such as prison hospitals), and hospitals with fewer than six beds staffed for patient use, are excluded.

This database proved to be of no use since it does not contain a text field for describing the circumstances that led to the patient being hospitalized in the first place.

IV. Discussion of Research Results

A. Carbon Monoxide

Information found through the research for this report indicates that somewhere between 200 and 250 deaths a year that are not known to be suicides result from vehicle-generated carbon monoxide. These types of deaths occur more frequently than deaths from any of the other issues researched.

1. 1998 Death Certificates

As of the writing of this report, 122 incidents involving 140 deaths have been located in 1998 death certificates. The 1998 deaths found in death certificates project to 190 deaths in all of the 1998 death certificates that have been identified for this study, including those that have not yet been received. Victims of this hazard are predominantly adults. Only five of the 140 deaths located in death certificates were children less than 10 years of age.

Among the scenarios encountered multiple times are someone working on or sitting in a running vehicle with the garage door closed, an intoxicated person who passes out in a car in a garage with a vehicle running, and persons who are killed in a residence when someone unintentionally leaves a vehicle running in a garage attached to a home. Both the numbers and types of incidents found in death certificates were supported by information found in other sources.

Details beyond what is contained in death certificates were found for some of the cases in news articles located in LexisNexis™ as were incidents for years more recent than 1998.

Summary data relating to vehicle-generated carbon monoxide deaths found in 1998 death certificates appear in Table II below. Basic information about each of the incidents, including an indication of whether or not the death was located in LexisNexis™ as well, may be found in the Appendix I to this report.

Table II: Summary Data: Vehicle-Generated Carbon Monoxide Deaths From 1998 Death Certificates

Age	# of Deaths	In Garage, Home or Residence		Other Location
		In vehicle	Not in vehicle or unclear	
90 +	5	1	4	
80-89	20	1	19	
70-79	15	1	14	
60-69	8	1	7	
50-59	10	3	6	1
40-49	16	4	12	
30-39	32	15	13	4
20-29	23	10	8	5
10-19	6	3	2	1
0-10	5	2	3	
Subtotal	140	41	88	11
Total	140	140		

2. LexisNexis™

The table below reflects the vehicle-generated carbon monoxide deaths and injuries that were located in LexisNexis™ for the period 1998-2002. The figures for 1998 include 26 deaths for which both death certificates and articles in LexisNexis™ were found. Four of the deaths that were found only in LexisNexis™ occurred in states from which death certificates had not been received. The remaining deaths found in LexisNexis™ were not found in the death certificates selected for review according to the criteria described previously in this report.

Table III: Carbon Monoxide Deaths and Injuries Found In LexisNexis™ (1998-2002)

Year	Total Incidents	Deaths	Injuries
1998	22	42	1
1999	17	27	15
2000	13	18	8
2001	12	22	0
2002	11	14	9+ (number of victims in one incident was not specified)

3. Literature Review

Numerous articles, including several from sources other than those at the National Library of Medicine, relating to carbon monoxide poisoning from vehicle-generated carbon monoxide were found. The findings of these articles are for the most part consistent with what was found in death certificates regarding vehicle-generated carbon monoxide incidents. In general, these articles reported on the number of such incidents nationally or in prescribed geographic areas or they reported on the kinds of circumstances that led to carbon monoxide poisonings. The articles reviewed are in the list of references at the back of this report.

Unintentional poisonings from vehicle-generated carbon monoxide diminished toward the close of the 20th century, with a particular decline in these types of incidents noted in the years following 1975 when catalytic converters were introduced into automobiles. [1, 2] The steady decline from 4.0 to 0.9 deaths per 1 million person-years since 1975 represents a 76.3 percent decrease. The total number of 1998 unintentional motor vehicle-related deaths from carbon monoxide has been reported at 238. Most of these deaths involved adults. [1].

Vehicle-generated carbon monoxide deaths tend to occur more often in colder climates and colder months of the year. [3, 4] Significant snow accumulation has also been associated with spikes in incidents of motor vehicle-related carbon monoxide poisonings and deaths when people sit in operating vehicles with tailpipes obstructed by snow. [5]

Alcohol intoxication is frequently involved in motor vehicle-related carbon monoxide deaths when intoxicated persons pass out in circumstances that expose them to this hazard. [4, 6, 7]

Death certificate research and other sources indicate that vehicle-related carbon monoxide poisonings and deaths tend to occur when the vehicle is not moving and particularly when the vehicle is operating in an enclosed space. However, a consistent level of accidental vehicle-related carbon monoxide deaths, between 60 and 75 per year, while the vehicle is moving has also been reported. [8] A report on a group of 68 cases, including one death, over a five-year period identified a specific danger to children riding in the backs of pickup trucks. [9]

Older vehicles have been associated with an increased risk of carbon monoxide poisonings. [7]

Data from the various articles reviewed dealing with vehicle-related carbon monoxide deaths is presented in Appendix II.

B. Backing

1. 1998 Death Certificates

As of the writing of this report, 91 backing deaths have been identified in the 4,046 death certificates that have been received. A straight-line projection based on these figures suggests that 123 backing deaths would be located in the approximately 5,500 death certificates from 1998 that have been identified for review. The situations in which these deaths occurred included both those that would be considered non-traffic and some that would be considered as traffic. The charts that follow present breakdowns of the 91 deaths.

Table IV: Backing Deaths Identified in 1998 Death Certificates By Age*

Age	# of Victims
1<	1
1-4	40
5-9	4
10-19	2
20-29	0
30-39	3
40-49	3
50-59	6
60-69	5
70+	27
Total	91

**Deaths involved occurred in both non-traffic and traffic situations*

Table V: Backing Deaths Identified in 1998 Death Certificates By Vehicle Type

Vehicle Type	# of Victims
SUV	3
Van/minivan	5
Pickup truck	11
Passenger Car	25
Truck - Delivery	3
Truck - Dump	8
Truck - Garbage/Recycling	4
Truck Other	13
Unclear	19
Total	91

Vehicle type is an example of information that is included in death certificates that may not get much attention from or may not be readily available to people who prepare final death certificates. This is best demonstrated by the high percentage (21%) of instances in which it was unclear as to the type of vehicle involved in a backing incident. It is not uncommon for the simple word "vehicle" or "automobile" to be used, which leaves no clear indication as to exactly the type of vehicle that was involved in the incident.

Table VI: Backing Deaths Identified in 1998 Death Certificates By Location

Location	# of Victims
Driveway	21
Home	21
Parking Lot	21
Road/Street	13
Sidewalk	2
Other off road	13
Total	91

A complete list of all of the backing incidents located in death certificates along with certain information relating to each may be found in Appendix III.

2. LexisNexis™

Table VII contains summary data reflecting the backing deaths and injuries that were found in LexisNexis™ for the years 1998-2002. Twenty-six (26) of the 1998 deaths were also located in death certificates. LexisNexis™ identified a number of 1998 backing deaths (19) that occurred in states from which death certificates were not received. The remaining 1998 backing deaths found in LexisNexis™ were not found in the death certificates selected for review according to the criteria previously described in this report.

Table VII: Backing Incidents (1998 – 2002) Found in LexisNexis™

Year	Total Events	Multiples (more than one victim involved)	Deaths	Injs.	<1 yr. old	1-4	5-12	13-21	22-64	>64	Car	Pickup	Van, Minibus or SUV	Gbge./ Dump Truck	Truck-Other	Other/Un-specified
'98	68	1	56*	13	1	34	9	0	14	11	15	10	10	2/6	13	12
'99	52	1	42	11	1	22	5	2	14	9	16	7	7	4/4	12	2
'00	56	4	47	13	0	33	4	0	17	6	16	10	9	1/6	11	3
'01	58	1	50	9	0	27	3	1	17	11	11	10	8	9/6	10	4
'02	63	2	55	10	0	34	3	2	14	12	8	15	11	8/5	11	5
Total	297	9	250	56	2	150	24	5	76	49	66	52	45	24/27	57	26

**Includes 26 deaths that were also found in death certificates.*

3. Fatality Analysis Reporting System

Table VIII contains summary data relating to the 102 backing incidents found in FARS in 2000 and 2001. Fourteen (14) of these backing incidents were located in LexisNexis™ as well. Table IX provides summary data relating to the location of the backing incidents found in FARS. Detailed information about each of the 102 backing incidents that was found in FARS may be found in Appendix IV.

Table VIII: Summary Data from Backing Deaths Identified in FARS – 2000, 2001

Year	Total Events	Multiples	Deaths	Injs.	<1	1-4	5-12	13-21	22-64	>64	Car	Pick up	Van, Minibus, SUV or station wagon	Gbge Truck	Truck-Other	Other/ unspecified
'00	57	4	57	4		18	4	1	12	26	15	12	19	3	5	3
'01	45	3	45	6*		12	3	3	8	22	11	9	12	5	1	7
Total	102	7	102	10*		30	7	4	20	48	26	21	31	8	6	10

**The age of three of the injured was not given. These three are therefore not included in the totals for any of the age groups indicated.*

Table IX: 2000, 2001 Backing Deaths Identified in FARS By Location

Location	2000	2001
Driveway	24	20
Parking Lot	4	1
Road/Street	14	14
Other/Unclear	15	10
Total	57	45

4. Literature Review

Death certificate research and an examination of other sources confirm that the annual number of deaths resulting from vehicles backing up is small in comparison to deaths due to other types of vehicle crashes. In spite of these relatively small numbers, there are certain characteristics of these incidents that emerged from both the original research conducted for this report and in academic research examined.

Very young children, particularly those between one and four years of age, seem especially vulnerable to being killed by a vehicle backing up. [10-15] Off-road locations, such as driveways and parking lots, are common locations where backing incidents occur. [11-14, 16, 17] The drivers of vehicles involved in these types of incidents are often parents, relatives or other people, such as neighbors, known to the family of the children involved. [10, 17] Larger vehicles for personal use, such as SUVs, van and pickup trucks, are often the vehicles involved in these types of incidents. [10-12]

Summaries of research articles reviewed for this report, and selected data from those articles, are provided in Appendix V.

5. Injury Databases

While a smattering of information relating to injuries and the issues under study was found in other sources, the National Electronic Injury Surveillance System (NEISS) of the Consumer Product Safety Commission (CPSC) and NHTSA's General Estimates System (GES) represented particularly good sources of data specifically relating to non-traffic and non-crash injuries, especially those resulting from backing incidents. The somewhat disparate results found in these two sources, however, make it difficult to make any but very broad statements regarding backing injuries.

Nearly 6,700 backing injuries were found in a recent year's worth (July 1, 2000 to June 30, 2001) of NEISS data. More than 85 percent of the injured were "treated and released." Nearly 2,400 average annual backing incidents were found in five years worth of GES data. More than 83 percent of these backing injuries were recorded as either "no injury," "possible injury," or "non incapacitating evident injury." The primary reason for the disparity in the data between the two sources is the completely different methods by which the data were gathered and the different people involved. NEISS gathers data from a probability sample of 100 hospital emergency departments. GES gathers its data from a representative sample of police reported motor vehicle crashes. Clearly there are backing incidents resulting in injury, usually minor, that cause the injured person to seek medical help, but that occur under circumstances that do not warrant a police report. In fact, several sources examined for this report suggested that about half the motor vehicle crashes in the country are not reported to the police. What seems to be

true about vehicle-related backing injuries, based on the NEISS and GES data, is that there are several thousand such injuries a year and the majority of the injuries involved are minor.

Data derived from NEISS and GES is contained in Appendix VI.

C. Vehicle Heat

1. 1998 Death Certificates

Passenger Compartment

As of this writing, a total of 22 deaths from heat exposure inside the passenger compartment of a motor vehicle have been located in the death certificates reviewed. A straight-line projection based on these results indicates that ultimately 29 vehicle heat deaths would be found in all the death certificates from the states. Six of the victims were adults. All of the other victims identified were four years old or younger.

The study of 1997 death certificates found 25 passenger compartment heat-related deaths, which projects to a total of 27 such deaths. This is consistent with the 1998 findings.

Trunk

Seven of the 11 trunk entrapment deaths that were the impetus for the establishment of the new Federal Motor Vehicle Safety Standard, (FMVSS) No. 401; Internal Trunk Release were confirmed in 1998 death certificates received. Death certificates for the four other deaths were not received because no death certificates from the state in which those deaths occurred had been received at the time this report was finalized. Other deaths from trunk entrapment that were located in news accounts in LexisNexis™ are reported on in the next section.

A complete listing of each passenger compartment vehicle heat incident along with basic information relating to each appears in Appendix VII.

2. LexisNexis™

Passenger Compartment

A total of 117 deaths of persons who died inside the passenger compartment of a vehicle from excessive heat were located in LexisNexis™ for the five-year period 1998-2002. Of the 24 vehicle heat-related deaths found in LexisNexis™ for 1998, thirteen (13) matched deaths that were located in death certificates. Four 1998 vehicle heat deaths found in LexisNexis™ occurred in states from which death certificates were not received. The remaining deaths were not found in the death certificates selected for review according to the criteria previously described in this report. Data reflecting the vehicle heat deaths found in LexisNexis™ appears in the table that follows.

Table X:1998-2002: Vehicle Heat Deaths & Injuries Found In LexisNexis™ By Age

Age	1998		1999		2000		2001		2002	
	Deaths	Injs	Deaths	Injs	Deaths	Injs	Deaths	Injs	Deaths	Injs
<1	9	2	6	3	6	1	11	2	11	7
1-4	14	2	16	2	8	4	17	5	12	4
5-9			1	4					2	3
10 -Adult	1				2					
Total	24*	4	23	9	16	5	28	7	25	14

Note: Additional victims who suffered no injury were also found in LexisNexis™ articles.
**Includes 13 deaths for which death certificates were also found.*

Trunk

A total of 16 incidents of unintentional trunk entrapment were found in LexisNexis™ dating back to 1987. These incidents involved a total of 25 deaths, one injury and one person who apparently did not sustain any injuries. The vast majority of the victims were young children ages six or younger with only four of the 27 victims outside that age range.

The six incidents and 15 deaths, all involving children six years of age or younger, found for the period 1987-1998 is less than what was found by the Centers for Disease Control and Prevention (CDC) in similar LexisNexis™ research published in the December 4, 1998 issue of the Morbidity and Mortality Weekly Report. That paper, titled "Fatal Car Trunk Entrapment Involving Children – United States, 1987-1998," found a total of 19 children six years of age or younger who died in nine incidents.

As indicated earlier, seven of the 11 trunk entrapment deaths that were the impetus for the establishment of a new Federal Motor Vehicle Safety Standard, (FMVSS) No. 401: Internal Trunk Release were located in 1998 death certificates received. All of these deaths were also located in LexisNexis™ as were the four 1998 trunk entrapment deaths for which death certificates were not received because, for various reasons, death certificates from the state involved were not obtained as part of this study. These 11 trunk entrapment deaths were the only such deaths identified as having occurred in 1998.

The tables that follow provide information on the distribution of incidents and deaths by year and the distribution of the ages of the victims of trunk entrapment.

Table XI: Trunk Entrapment Incidents Found in LexisNexis™: 1987 - 2003

Year	Incidents	Deaths	Injuries	No Injury
2003	1	1		
2002	1	1		
2001	3	3		
2000	3	4		
1999	2	1		1
1998	3	11*		
1995	1	2		
1994	1	1	1	
1987	1	1		

**Seven (7) of these deaths were also found in death certificates. Death certificates from the state in which the remaining four (4) deaths occurred were not received.*

Table XII: Age of Trunk Entrapment Victims, 1987 - 2003

Age	Number of Victims
2	2
3	6
4	8
5	3
6	3
9	1
10	1
12	1
25	1

3. Literature Review

Only two articles relating to vehicle heat were located. Both of these focused on measuring the extent to which passenger compartments heat up under various conditions. There was no discussion in either article of victims of vehicle heat incidents. [18, 19]

D. Vehicle Window

1. 1998 Death Certificates

Only four (4) deaths as a result of interaction with a vehicle window have been located in 1998 death certificates received. The ages of the victims were 2, 3, 3, and 6. Two involved a power window. One apparently did not. Whether a power window was involved in the fourth case is unclear. In one incident a child was left fastened in a car seat while the child's parent went back into the house. The child somehow got out of the car seat and leaned on the power window switch, which caused the window to rise and strangle the child. Another incident involved a young child playing with other children. The child got into a vehicle, opened the power window to yell to the other children and then hit the power switch causing the window to go back up on the child's neck. In the third incident, a child apparently pulled itself up while on the outside of a vehicle, stuck its head through a partially open window, slipped, caught its neck between the window and the door frame and was strangled. The circumstances of the fourth incident were unclear beyond the fact that the child involved was strangled as a result of interaction with a vehicle window.

The study of 1997 death certificates also found four (4) deaths of children that resulted from interaction with a power window. Only two of these could be confirmed as clearly involving a power window.

2. LexisNexis™

For the years 1998-2002, a total of 12 vehicle window incidents were located in LexisNexis™. Eleven children died as a result of these incidents. One of these eleven deaths involved a sunroof, the only such incident located as part of this research. One child was injured.

Summary information relating to these incidents appears in the table below.

Table XIII: 1998-2002: Vehicle Window Cases From LexisNexis™

Year	Deaths/Injuries	Power Window	No Power Window or Unclear	Ages of Victims
1998	5*/0	3*	2	6, 3, 3, 2, 2
1999	1/0	1	0	2
2000	0/0	0	0	-
2001	2/1	3	0	3, 2, 2
2002	3/0	3	0	6, 3, 2

**Includes one vehicle sunroof incident*

One of the power window deaths in the preceding chart involved an anomalous situation in which someone had apparently rewired the vehicle to allow the power windows to operate even when the keys were not in the ignition.

All four of the vehicle window incidents found in 1998 death certificates were also found in LexisNexis™. The 1998 sunroof death occurred in a state from which death certificates were not received and therefore was not found in death certificates. As indicated earlier, this single sunroof incident was the only such incident found in any source as a result of the research conducted for this report.

3. Literature Review

Three articles were found relating to the hazard of strangulation in a vehicle window. Two of these reported on individual cases that occurred in the United States rather than on an evaluation and analysis of data derived from multiple cases. [20, 21] The third estimated that there are about 499 minor injuries annually, mostly to fingers and wrists, attributable to power windows with most of these, about 64 percent, involving children 14 years of age and younger. [22]

These articles are more fully described in Appendix VIII.

V. Conclusions

This study determined that death certificates represent the best available source for identifying deaths that result from non-traffic and non-crash incidents involving a motor vehicle. However, even a comprehensive review of death certificates will not identify every non-traffic or non-crash death. This study, for example, found news reports of non-traffic or non-crash motor vehicle related deaths for which death certificates should have been found, but were not. A variety of factors can explain this, such as errors in coding on death certificates or a focus in the death certificate on the precise and immediate medical cause of death rather than the fact that the precipitating cause was motor vehicle related.

As to the specific issues investigated, this study found the following.

- *Carbon monoxide* – The number of deaths found in 1998 death certificates suggests there are about 200 unintentional deaths a year, nearly all adults, from vehicle-generated carbon monoxide. Other sources examined found a similar, although somewhat higher number. These deaths most often do not involve moving vehicles, but rather vehicles left running in enclosed spaces. Some victims identified were under the influence of alcohol at the time of their death.
- *Vehicles backing up* – Based on deaths found in 1998 death certificates, about 120 deaths of persons struck by a vehicle backing up occur annually. Most of the victims are either very young (less than five years old) or elderly (60 and above), with most of the elderly victims over age 70. As many as 6,000 injuries, mostly minor, occur each year as a result of these types of incidents.
- *Excessive heat inside a vehicle passenger compartment* - Deaths found in 1998 death certificates project to a national total of 29 deaths annually of persons exposed to excessive heat inside a vehicle passenger compartment. A similar projected level of annual deaths (27) from this cause was found in the agency's previous study of 1997 death certificates.
- *Vehicle window* - Four deaths resulting from interaction with a vehicle window were found in 1998 death certificates. The agency's study of 1997 death certificates also found four deaths involving interaction with a vehicle window.

VI. References

1. Mott JA, Wolfe MI, Alverson CJ, Macdonald SC, Bailey CR, Ball LB, Moorman JE, Somers JH, Mannino DM, Redd SC. *National vehicle emissions policies and practices and declining US carbon monoxide-related mortality.* JAMA 2002;Aug 28;288(8):988-95.
2. Shelef M. Unanticipated benefits of automotive emission control: reduction in fatalities by motor vehicle exhaust gas. Sci Total Environ 1994 May 23;146-147:93-101.
3. Death from motor-vehicle-related unintentional carbon monoxide poisoning – Colorado, 1996, New Mexico, 1980-1985, and United States, 1979-1992. MMWR Morb Mortal Wkly Rep 1996 Nov 29;45(47):1029-32.
4. Girman JR, Chang YL, Hayward SG, Liu KS. Causes of unintentional deaths from carbon monoxide poisonings in California. West J Med 1998 Mar;168(3):158-65.
5. Rao R, Touger M, Gennis P, Tyrrell J, Roche J, Gallagher EJ. Epidemic of accidental carbon monoxide poisonings caused by snow-obstructed exhaust systems. Ann Emerg Med 1997 Apr;29(4):561.
6. Yoon SS, Macdonald SC, Parrish RG. Deaths from unintentional carbon monoxide poisoning and potential prevention with carbon monoxide detectors. JAMA 1998 Mar 4;279(9):685-7.
7. Baron RC, Backer RC, Sopher IM. Unintentional deaths from carbon monoxide in motor vehicle exhaust: West Virginia. Am J Public Health 1989 Mar;79(3):328-30.
8. Fatalities Associated With Carbon Monoxide Poisoning From Motor Vehicles, 1995-1997. Research Note, April 2000, National Highway Traffic Safety Administration.
9. Hampson NB, Norkool DM. Carbon monoxide poisoning in children riding in the back of pickup trucks. JAMA 1992 Jan 22-29;267(4):538-40.
10. Brison RJ, Wicklund K, Mueller BA. Fatal pedestrian injuries to young children: a different pattern of injury. Am J Public Health 1988 Jul;78(7):793-5.
11. Winn DG, Agran PF, Castillo DN. Pedestrian injuries to children younger than 5 years of age. Pediatrics 1991 Oct;88(4):776-82.
12. Agran PF, Winn DG, Anderson CL. Differences in child pedestrian injury events by location. Pediatrics 1994 Feb;93(2):284-8.
13. Partrick BA, Bensard DD, Moore EE, Partington MD, Karrer FM. Driveway crush injuries in young children: a highly lethal, devastating, and potentially preventable event. J Pediat Surg 1998 Nov;33(11):1712-5.
14. Nadler EP, Courcoulas AP, Gardner MJ, Ford HR. Driveway injuries in children: risk factors, morbidity, and mortality. Pediatrics 2001 Aug: 108(2):326-8.
15. Nonoccupant Fatalities Associated With Backing Crashes. Research Note, Revised February 1997, National Highway Traffic Safety Administration.
16. Silen ML, Kokoska ER, Fendya DG, Kurkchubasche AG, Weber TR, Tracy TF. Rollover injuries in residential driveways: age-related patterns of injury. Pediatrics 1999 Jul;104(1):e7.
17. Di Scala C, Sege R, Guohua L. Outcomes of Pediatric Pedestrian Injuries By Locations of Event. 45th Annual Proceedings, Association for the Advancement of Automotive Medicine, Sept. 24-26, 2001.
18. Surpure JS. Heat-related illness and the automobile. Ann Emerg Med 1982 May; 11(5):263-5
19. Roberts KB, Roberts EC. The automobile and heat stress. Pediatrics 1976 Jul;58(1):101-4.
20. Simmons GT. Death by power car window. An unrecognized hazard. Am J Forensic Med Pathol 1992 Jun;13(2):112-4.
21. Strauss RH, Thompson JE, Macasaet A. Accidental strangulation by a motor vehicle window. Pediatr Emerg Care 1997 Oct;13(5):345-6.
22. Injuries Associated With Hazards Involving Motor Vehicle Power Windows. Research Note, May 1997, National Highway Traffic Safety Administration.

VII. Appendices

Appendix I - Vehicle-Generated Carbon Monoxide Deaths From 1998 Death Certificates

Table XIV: Vehicle-Generated Carbon Monoxide Deaths From 1998 Death Certificates

#	Age(s)	Location	Description	Found in LexisNexis™
1	38	parking lot	intake of alcohol; vehicle engine left running damaged exhaust system	yes
2	80, 82	in home, car in garage	one victim apparently forgot to turn off car after pulling into garage, victims found inside home	yes
3	29	garage	overcome by fumes in closed garage	yes
4	72	garage	sitting in car parked in garage with motor running	
5	91	residence	vehicle engine left running in closed integral garage	
6	76	home	car idling in garage below living quarters	
7	70	garage	motor home left running in garage	
8	28	garage	fell asleep in truck in closed garage	
9	51	barn	overcome by carbon monoxide while working on vehicle in barn	
10	82	garage	vehicle left running in integral garage	
11	53	garage	victim was found slumped over in auto parked in the garage behind residence	
12	82	bedroom	decedent went to bed & left vehicle running	
13	49	garage	was working on car in garage with hose leading from exhaust to outdoors, but hose had leak	yes
14	68, 64	at home	inadvertently inhaled automobile gas fumes - accident	
15	64	residence	inhaled auto exhaust fumes	
16	84, 66, 37	residence (car)	no further details available	
17	32	home	the subject inhaled exhaust fumes from a motor vehicle in a closed garage	
18	34	home	inhaled automobile exhaust	
19	83	at home	inhaled automobile fumes while inside of residence	
20	83	home	left car running in attached garage	
21	4, 8, 9, 10, 21, 26, 29, 33	residence	eight died of apparent carbon monoxide poisoning - believed that poisoning occurred when two of victims left truck running in the garage as they listened to the radio – other victims in home	yes
22	32	garage	sat in running vehicle in enclosed garage listening to music while intoxicated with alcohol	
23	80, 72	at home	inhaled automobile exhaust fumes	
24	27	at home	inhaled automobile exhaust fumes - alcohol intoxication cited	
25	58	parking lot	CO poisoning	
26	46	probably vehicle	unknown source of carbon monoxide	
27	70	home garage	decedent unexpected found down in garage	
28	26	at home	inadvertently left vehicle engine on	
29	34, 26	garage/in vehicle	deceased in car in closed garage with engine running—drinking apparently involved	yes
30	83	home	vehicle accidentally left running in garage	
31	48	in car in garage/home	subject inhaled auto exhaust fumes	

#	Age(s)	Location	Description	Found in LexisNexis™
32	34	dirt path	used drugs & inhaled exhaust fumes from car	
33	21	auto	subject inhaled auto exhaust fumes	
34	35	garage	inhaled car exhaust	
35	48	home-garage	was working on car and was overcome by carbon monoxide	
36	6	home	was placed in car in garage by parent and exposed to carbon monoxide	yes
37	52	home	was found in garage working on automobiles	
38	70, 71	home	inhaled exhaust fumes from car in garage	yes
39	36	home-garage	was found in automobile inside closed garage	
40	39	garage	was found in automobile in closed garage- diabetic, depression, alcohol abuse - accident	
41	40	home-auto	accidental exposure to carbon monoxide	
42	57	garage	working on car in closed garage	
43	26	home	sat in running automobile with garage closed up	
44	17	motor vehicle	auto exhaust	
45	30	garage	inhalation of auto exhaust fumes	
46	26	garage	passed out in vehicle with engine running in enclosed garage - acute ethanolism	
47	41	garage	passed out in vehicle parked in garage while car was running	
48	33	garage	started vehicle in enclosed garage, apparently fell asleep after turning vehicle off – acute ethanolism	
49	97	garage	subject found in running car enclosed in garage	
50	41	residence	inhalation of exhaust fumes	
51	83	residence	auto exhaust fumes, vehicle left running	
52	22	parking lot	fumes from exhaust of vehicle	
53	48	home	exposure to carbon monoxide while working on auto in closed garage	
54	35	residence	in running vehicle with exhaust leak	
55	31	church assembly grounds	found in car, while painting car, with engine running, in closed garage	
56	36	garage	found in enclosed garage on floor with stalled car	
57	85	home	in motor vehicle in his garage motor running	
58	38	home	after drinking heavily, victim drove car into garage, closed door, apparently fell asleep at wheel with the car still running	
59	16	off-road	decedent found parked in vehicle with key on, all windows closed, body was in decomposed state	
60	31	garage	acute carbon monoxide intoxication	
61	64	car (in garage)	inhaled car exhaust fumes	
62	33	garage	sleeping in car inside garage after consuming large amounts of alcohol at party	
63	23	highway	decedent was riding in back seat of automobile with faulty exhaust system	
64	36	garage	breathed automobile exhaust fumes in enclosed garage	
65	39	residence - garage	inhalation of motor vehicle exhaust in an enclosed garage	
66	17, 18	street	the two died of carbon monoxide poisoning after apparently falling asleep in vehicle, which had been idling for hours with the windows closed	yes

#	Age(s)	Location	Description	Found in LexisNexis™
67	63, 58	at home	couple found in bed, which is directly over the house's garage-police said a car inside the garage had been running for some time	yes
68	51	garage	in auto in garage, carbon monoxide intoxication	
69	82	garage	running car in garage	
70	16	garage	running car in garage	yes
71	83	home	car running in garage	
72	75	home	happened in "own home - car left running"	
73	36	garage	fell asleep in truck in closed garage - acute alcohol intoxication	
74	76, 70	home	car accidentally left running in a closed garage killed an elderly couple when the deadly gases seeped into their bedroom	yes
75	73	home	accidentally left car running in house's attached garage	yes
76	21	garage	working on a truck in a closed garage	
77	49	garage	appears overcome by auto exhaust fumes in closed garage clouded judgment by alcohol	
78	90	garage	accidental fall near running car in garage	
79	38	residence	inhaled automobile exhaust while intoxicated with methamphetamine	
80	72	garage	overcome by car fumes in a closed garage	
81	84	residence	deceased accidentally left car running in garage and entered house to go to bed - passage door from garage was left open for pet to enter the house.	
82	76	residence	vehicle exhaust -carbon monoxide poisoning	
83	44	in auto in garage	asphyxia by carbon monoxide-inhaled auto exhaust fumes in closed garage	
84	24	in auto in garage	acute ethanol and carbon monoxide intoxication, sat in vehicle in garage listening to the radio drinking alcohol with the engine running & inhaled poisonous fumes	
85	91	garage	cause of death-carbon monoxide poisoning -auto exhaust	
86	80	residence	defective air handler blew automobile exhaust from garage and into home; died during sleep	
87	79	at home	acute carbon monoxide poisoning, inhalation of vehicle exhaust	
88	51	in auto in garage	found unresponsive in driver seat of car in enclosed garage: exposed to automobile exhaust fumes - acute alcohol intoxication	
89	26	in auto in wooded area	subject abused ethanol and later inhaled exhaust fumes of auto, inadvertently, sitting in auto	
90	81	at home	apparently disoriented decedent left car running in garage-victim had Alzheimer's	
91	37	in auto at residence	found in auto – cause of death –carbon monoxide poisoning	
92	82	garage	subject inhaled automobile exhaust fumes	
93	23	in car, off road	decedent found parked in vehicle with key on, all windows closed, body was in decomposed state	
94	29	garage	inhaled motor vehicle exhaust	
95	84	garage	being in garage with motor running	
96	62	garage	victim was intoxicated, drove into garage, left car running, fell asleep, overcome by CO fumes	
97	34	home	carbon monoxide poisoning - in car with motor running	
98	89	home	left car running in garage	
99	52	garage	ran car engine in enclosed garage (of residence)	
100	24	street	defective exhaust system on car - carbon monoxide poisoning	

#	Age(s)	Location	Description	Found in LexisNexis™
101	33	garage	found in van in closed garage with motor running	
102	51	garage	inhaled car exhaust fumes	
103	28	home	car running in garage - accident	
104	32	next to vehicle	inhaled carbon monoxide	
105	43, 41	residence	inside closed garage with car running - mixed drug and alcohol intoxication	
106	32	home/ garage/ vehicle	inhaled carbon monoxide, acute carbon monoxide poisoning	
107	21	home	found in auto at carport of home with motor on	
108	20	vehicle – on a road	fell asleep in enclosed vehicle with engine idling	
109	29	vehicle/ dwelling - driveway	inhaled car exhaust fumes	
110	37	home	mixed drug and carbon monoxide poisoning-drug usage and car exhaust	
111	43	home	working on vehicle in an enclosed building	
112	46	home	carbon monoxide fumes leaked from faulty exhaust thru rusted floor of vehicle	
113	42	garage	car running in closed garage	
114	47	home	passed out due to migraine while car was running	
115	60	home	working under truck	
116	1	van in field	inhaled combustion fumes	
117	83	home	found lying next to auto	
118	70	garage	overcome by car exhaust while working on running car in closed garage	
119	38	garage	bundled up to sleep in running car – CO and ethanol intoxication	
120	38	garage	found in garage	
121	33	auto	accidental CO poisoning in auto	
122	96	garage	inhalation of auto exhaust	

Appendix II - Summaries Of and Data From Articles On Poisonings From Vehicle-Generated Carbon Monoxide

The thrust of the research effort behind this report was to gather data, from whatever source, on selected non-traffic motor vehicle related safety hazards. The sources reviewed included academic research articles. The basic findings of the articles reviewed are presented in the body of this report. A brief summary of each article reviewed and selected data from each article is presented here.

Mott JA, Wolfe MI, Alverson CJ, Macdonald SC, Bailey CR, Ball LB, Moorman JE, Somers JH, Mannino DM, Redd SC. *National vehicle emissions policies and practices and declining US carbon monoxide-related mortality.* JAMA 2002;Aug 28;288(8):988-95.

This comprehensive study examined 31 years (1968-1998) of national mortality and motor vehicle emissions data. The study describes the reductions in overall carbon monoxide related deaths during this period and particularly the reductions in motor vehicle-related carbon monoxide deaths. While rates of reduction varied during portions of the 31-year period studied, overall unintentional motor vehicle-related carbon monoxide death rates declined from 20.2 deaths to 8.8 deaths per 1 million person-years, or about 57.8 percent. After 1975, the year in which catalytic converters were introduced into automobiles, the authors found a reduction in vehicle-related carbon monoxide deaths of 76.3 percent, a decline from 4.0 to 0.9 deaths per 1 million person-years. While not drawing any hard and fast conclusions, the authors nonetheless felt compelled to comment on this saying, "the concurrent decline in motor vehicle-related emissions and poisoning deaths that only occurred following the first national intervention to reduce CO in automobile exhaust appears unlikely to be coincidental."

Two areas of data presented in this article are of particular value to the non-traffic research in this report. First, there were 238 unintentional motor vehicle-related deaths from carbon monoxide in 1998,, which is consistent with both other articles summarized below and the death certificate research conducted for this report. It adds to the certainty as to the magnitude and scope of the problem. Second, the data presented in the study (see table below) indicate that vehicle-related carbon monoxide deaths primarily affect adults, which is again consistent with information derived from death certificate research and other sources.

Table XV: (from Mott JA, et.al.) 1998 CDR (crude death rate) per 1 Million Person-years (No. of Deaths)

Age	
<5	0.16 (3)
5-14	0.13 (5)
15-34	0.97 (74)
35-64	0.99 (101)
≥65	1.60 (55)

Shelef M. *Unanticipated benefits of automotive emission control: reduction in fatalities by motor vehicle exhaust gas*. Sci Total Environ 1994 May 23;146-147:93-101.

This article is simply noted here because it also documents what is more completely described in the article cited above.

***Fatalities Associated With Carbon Monoxide Poisoning From Motor Vehicles, 1995-1997*. Research Note, April 2000, National Highway Traffic Safety Administration.**

Figures presented in this note are consistent with the article by Mott et. al. and the death certificate research conducted in support of this report. Of particular note is the fact that this note identified a consistent annual number of vehicle-related carbon monoxide deaths in moving vehicles, something that the researchers involved in this report did not find, although one such incident was located. Also, the note presented data that support the notion that carbon monoxide poisonings from motor vehicle exhaust are more likely to occur in the cooler months. Data from this article relevant to the research on which this report is based appear in the following tables.

Table XVI: (from NHTSA Research Note) Vehicle-Related Deaths Associated With CO Poisoning: 1995-1997*

	Nature of Death	1995	1996	1997	Total
Stationary vehicles	Accidental (%)	234 (11.9)	223 (12.4)	208 (12.9)	665 (12.4)
	Unknown (%)	67 (3.4)	61 (3.4)	41 (2.5)	169 (3.1)
Moving vehicles	Accidental	73	59	61	193

**Suicides were intentionally left out of this chart. Percentages are based on totals that include suicides.*

Table XVII: (from NHTSA Research Note) Accidental CO Fatalities with Stationary Vehicles by Vehicle Location: 1995-1997

Vehicle Location	1995	1996	1997	Total
At home	126 (53.8)	149 (66.8)	122 (58.6)	397 (59.7)
On Public Roadway	6 (2.6)	7 (3.2)	7 (3.4)	20 (3.0)
Other Locations	102 (43.6)	67 (30.0)	79 (38.0)	248 (37.3)
Total	234	223	208	665

Table XVIIIVIII: (from NHTSA Research Note) All Accidental Vehicle-Related CO Fatalities in 1995-1997 by Season of Occurrence

Season	1995	1996	1997	Total
Fall	77 (25.1)	62 (22.0)	77 (28.6)	216 (25.2)
Winter	105 (34.2)	109 (38.6)	89 (33.1)	303 (35.3)
Spring	76 (24.7)	63 (22.3)	71 (26.4)	210 (24.5)
Summer	49 (16.0)	48 (17.1)	32 (11.9)	129 (15.0)
Total	307	282	269	858

Marr LC, Morrison GC, Nazaroff WW, Harley RA. *Reducing the risk of accidental death due to vehicle-related carbon monoxide poisoning*. J Air Waste Manag Assoc 1998 Oct;48(10):899-906.

Rather than focus on the numbers of incidents of carbon monoxide poisoning, this paper sets out measures of the risk of carbon monoxide poisoning in the typical settings in which most of the carbon monoxide poisonings continue to occur. Using various data sources and methods of statistical analysis, the authors came up with the relative risk of death in a number of situations. That is reflected in the table below.

Table XIX: (from Marc LC et. al.) Risk of Death for Four Accidental Poisoning Scenarios With All vehicles and With Pre-1975 Vehicles Removed

Location	Exposure Duration (hr)	All Vehicles	Post-1975 Vehicles Only
garage	1	3.5-7.7%*	1.7-5.6%*
garage	3	16-21%	12-16%
residence	1	0.0%	0.0%
residence	3	9.5%	3.1%

**A range in the risk of death in garages is presented because of uncertainty in garage air-exchange rates.*

The garage size assumed in determining the risk factors above is 90 m^3. Changes in the size of the garage would affect the risks of carbon monoxide poisoning, the authors note. They also cite a number of other factors that would affect the risks involved. These include:

- The extent to which a garage is tightly sealed - "Oxygen depletion in a tightly sealed garage could perturb the air-to-fuel ratio in the engine and cause a clean vehicle to become a gross polluter."
- The effect of a cold start on CO emissions – A cold start would, initially at least, increase the amount of carbon monoxide released by a vehicle because "the fuel-air mixture is intentionally enriched to facilitate ignition and to improve cold-engine operation, and the automobile's catalytic converter is not warm enough to function efficiently."
- The effect of a vehicle idling for a long period of time – "the catalyst may never reach a high enough temperature to operate effectively."

Another factor that could confound the authors' results is "the distribution of garaged vehicles versus vehicle age." "This study has assumed that all vehicles tested in the random roadside emissions inspection are equally likely to be parked in an enclosed garage, but it is possible that a higher fraction of newer vehicles are kept in garages because of socioeconomic factors. It this were true, then the risk of death from CO poisoning has been overestimated because the older vehicles, which are responsible for a disproportionately high fraction of deaths, would be less likely to be parked in enclosed garages."

What is interesting about the risk factors presented in this paper is that they are based on what is fairly prolonged exposure to the exhaust from an operating vehicle. As indicated earlier in this report, there have been significant declines in deaths from vehicle-generated carbon monoxide over the past 30 years. Also, the current numbers of vehicle-generated carbon monoxide deaths is quite small. With the addition of the risk factors developed by this paper, a

picture emerges, which is consistent with information derived from other sources and provided in this report, that suggests that in the majority of cases of accidental carbon monoxide poisonings from vehicle exhaust, factors beyond the vehicle itself play a major role. These factors may include alcohol abuse or serious errors or lapses in judgment on the part of the victim, such as simply forgetting to turn off an operating vehicle in a garage that is attached to a home.

Girman JR, Chang YL, Hayward SG, Liu KS. *Causes of unintentional deaths from carbon monoxide poisonings in California.* West J Med 1998 Mar;168(3):158-65.

Based on unintentional vehicle-related carbon monoxide deaths in California over a 10-year period (1979 to 1988), this study supports certain characteristics of these types of deaths. Among the article's findings:

- 59 of the 136 unintentional deaths from vehicle-generated carbon monoxide were associated with alcohol use – "Typical cases involved drivers who, under the influence of alcohol, parked their cars in their garages and fell asleep without stopping their engine. Surprisingly, there were also cases involving decedents who experienced CO poisoning while drinking and listening to cassette tapes with the motor running, despite having parked their vehicles in the open."
- "California generally follows the national pattern with more deaths in the winter months and higher rates among males, African Americans and older persons."

***Death from motor-vehicle-related unintentional carbon monoxide poisoning – Colorado, 1996, New Mexico, 1980-1985, and United States, 1979-1992*. MMWR Morb Mortal Wkly Rep 1996 Nov 29;45(47):1029-32.**

As with the articles reported on above, this article provides further supporting information relating to the circumstances most frequently involved in vehicle-generated carbon monoxide poisonings. Among the findings of this article are:

- For the period 1979-1992, national death rates from CO poisoning (in stationary vehicles) were higher in most states in the northern regions of the United States, where winter temperatures are coldest, than in states in southern regions, which have warmer winter temperatures.
- Most motor vehicle-related CO deaths in garages have occurred even though the garage doors or windows have been open, suggesting that passive ventilation may not be adequate to reduce risk in semi-enclosed spaces.

Yoon SS, Macdonald SC, Parrish RG. *Deaths from unintentional carbon monoxide poisoning and potential prevention with carbon monoxide detectors*. JAMA 1998 Mar 4;279(9):685-7.

This study, which basically advocates more extensive use of carbon monoxide detectors, includes findings similar to those found in the paper by Girman, et. al. Alcohol levels of greater than 0.01 percent were found in 53 percent of those identified in the study as having died from motor vehicle-related carbon monoxide. (The study examined a total of 136 deaths from CO poisoning that were investigated by the New Mexico Office of the Medical Investigator, 1980 through 1995.)

Rao R, Touger M, Gennis P, Tyrrell J, Roche J, Gallagher EJ. *Epidemic of accidental carbon monoxide poisonings caused by snow-obstructed exhaust systems*. Ann Emerg Med 1997 Apr;29(4):561.

Snow obstructed exhaust systems represent special circumstances that substantially increase the risk of carbon monoxide poisoning from vehicle-generated carbon monoxide. This article reports on the spike in carbon monoxide poisonings that resulted when on January 8, 1996, the New York City metropolitan area was blanketed by more than 24 inches of snow. The article focuses on 25 cases of carbon monoxide poisoning, 18 during the first 24 hours following the snowfall, that were referred to a medical center in New York for hyperbaric oxygen treatment to offset the effects of the patients having been exposed to CO in a stationary automobile with the engine running and the exhaust system obstructed by snow. Usually the patients involved were attempting to keep warm. There was one death from CO in the city that was not included in the study. Twenty (20) of the 25 patients included in the study arrived unconscious at the emergency department.

Baron RC, Backer RC, Sopher IM. *Unintentional deaths from carbon monoxide in motor vehicle exhaust: West Virginia*. Am J Public Health 1989 Mar;79(3):328-30.

This article again supports several tendencies inherent in motor vehicle-related carbon monoxide deaths:

- Involvement of older vehicles: "Of 64 episodes involving 82 deaths investigated by the West Virginia Office of the Chief Medical Examiner, 1978-1984, 50 occurred outdoors in older vehicles with defective exhaust systems…"
- Blood alcohol was detected in 50 (68 percent) of 74 victims tested.

Hampson NB, Norkool DM. *Carbon monoxide poisoning in children riding in the back of pickup trucks*. JAMA 1992 Jan 22-29;267(4):538-40.

This study identified circumstances that represent a particular risk of carbon monoxide poisoning in children. The authors examined, through follow up telephone interviews, 68 patients treated with hyperbaric oxygen for accidental carbon monoxide poisoning between 1986 and 1991. These patients were treated at a private, urban, tertiary care center in Seattle, WA and ranged from 4 to 16 years old. Twenty (20) of these cases occurred as a result of the children riding in the back of pickup trucks. In 17 of these, the children were riding under a rigid closed canopy on the rear of the truck. In three cases the children rode beneath a tarpaulin. Fifteen (15) of the children who had been riding in pickups had lost consciousness. One died, one had permanent neurologic deficits, and 18 had no recognizable after effects of the carbon monoxide poisoning. In all 20 cases, the truck exhaust system had a previously known leak or tail pipe that exited at the rear rather than at the side of the pickup truck.

Appendix III - Backing Cases From 1998 Death Certificates and LexisNexis™

The following chart presents details of each 1998 backing incident that was identified in either death certificates or LexisNexis™. Information from the two sources is combined here into this single chart to demonstrate that the two information sources complement one another. Despite best efforts to come up with criteria that would provide 1998 death certificates that included all backing incidents, there were still backing incidents that resulted in death that were found in news accounts in LexisNexis™, but not identified through the death certificate research. It should be noted, however, that death certificates for many of the LexisNexis deaths may be found when the remaining death certificates are obtained.

Table XX: 1998 Backing Incidents Found in Death Certificates (DC) and LexisNexis™ (LN)

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
1	14 mos.	car	unclear	parent was parking car backing up	LN	injury
2	67	car	street	victim was crossing the street when hit by car backing out of store parking lot	LN	death
3	88	garbage truck	parking lot	pedestrian hit by garbage truck backing up, died next month	DC, LN	death
4	2	delivery truck	driveway of farm	truck was backing up in driveway of farm	DC, LN	death
5	7	pickup	parking space	driver was backing up pickup truck under tree, victim was on bicycle	LN	death
6	73	car	private property – probably parking lot	victim was struck by car backing out of parking space on private property	LN	injury
7	8, 5	truck	alley	victims were on skateboard, hit by truck backing down alley into condo complex	LN	8 – death 5 - injury
8	21 mos.	car	driveway	victim hit by car backing out of driveway - fractured skull	DC, LN	death
9	21 mos.	pickup	driveway	parent was backing out of driveway- pet ran under truck, someone scooted pet away, driver thought all the kids were out of the way	LN	death
10	31	truck	street	truck was backing up, hit and ran over victim crossing street in mid-block, beeper was working	LN	death
11	2	vehicle	driveway	elderly driver pulled into driveway to drop off residents of the home, as driver was backing out of the driveway, vehicle struck 2-year-old	LN	death
12	1	car	unclear	victim died after being accidentally run over by car, friend had been visiting family and was backing car up when the victim ran behind the car and was run over	LN	death

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
13	43	truck	unclear	43-yr-old victim died after being run over by friend who didn't realize was backing truck over friend, until police told driver, driver didn't know had run over friend	LN	death
14	1	car	driveway	parent thought three young children were safely waiting in front yard when backed out the car, felt a rear tire run over something and discovered that child had wandered into the path of the vehicle	LN	injury
15	19 mos.	pickup	driveway	parent accidentally backed pickup over victim in family's driveway	LN	injury
16	13 mos.	car	driveway	13-month-old died after being run over in driveway by parent backing out of driveway, parent did not know child was behind the car when backed up	DC, LN	death
17	18 mos.	car	driveway	run over in family's driveway, playing next to driveway when struck by sedan driven by family friend backing out, knocked under car when hit by bumper, then run over when the driver stopped, moved forward	DC, LN	death
18	adult	truck	street	crossing street, was struck and run over by a truck as it was backing up - driver apparently was unaware that there was anybody behind the truck.	LN	unclear
19	22 mos.	van	driveway	driveway of small apartment complex was play area for children - relative took victim outside to wave goodbye to parent, play w/children, before relative could react, victim walked behind a large van as it began backing out of driveway	LN	death
20	4	unclear	driveway	the accident occurred in a driveway, driver knew the child and was just backing up and thought the child was clear from the rear of the vehicle'	LN	death
21	86	unclear	driveway	driver accidentally ran over, killed friend, dropped friend off, began backing out of driveway, friend returned to passenger side, driver not aware of return, kept backing, struck friend then apparently accidentally accelerated instead of braking	DC, LN	death
22	2	car	driveway	backing up in car parent hit 2-year-old child, who was playing on the gravel driveway, police said	LN	injury
23	3	van	driveway	child killed when transit shuttle backed over child while child was riding tricycle, pedaled into neighbor's driveway just as 15-person van was backing out	LN	death

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
24	1	van	driveway	child was killed when relative accidentally ran over child while backing van out of a driveway in an apartment complex, pulled van out of a carport behind complex, backed vehicle around corner where child was sitting in driveway	DC, LN	death
25	18 mos.	vehicle	driveway	killed when parent hit child while backing a vehicle out of their driveway, police said - parent was not aware child was outside their home	LN	death
26	6	car	driveway	relative was backing car from driveway when child ran from house and jumped on the back of the car	DC, LN	death
27	19 mos.	car	driveway	driver was backing car out of a driveway when heard a loud thump from under the vehicle, child run over by car while parents watched.	DC, LN	death
28	4	van	driveway	parent was backing out of the driveway in the family van when child ran out of the family home and behind the van	LN	death
29	71	unclear	driveway	police said driver did not see victim as driver was backing out of the driveway	DC, LN	death
30	2 1/2	SUV	driveway	parent wanted to move vehicle to make room for a friend's truck in the driveway, as slowly backed out, felt impact	LN	injury
31	5	SUV	driveway	killed by the family Suburban while playing in the driveway – in article about dangers of backing	LN	death
32	1	unclear	unclear	parent backed over and killed his year-old child	LN	death
33	13 mos.	SUV	driveway	as parent backing vehicle out of garage, child had scampered out a side door (of house) into driveway into path of vehicle	DC, LN	death
34	3	pickup	driveway	sibling got in pickup truck didn't realize sibling was behind truck	DC, LN	death
35	5	unclear	driveway	sibling accidentally backed over victim in driveway	LN	death
36	2 mos.	pickup	driveway	parent brought baby outside in infant car seat, set it down in driveway while backed the pickup truck from garage	DC, LN	death
37	2	vehicle	driveway	2-year-old child was killed when a vehicle backed over that child in the driveway at child's home	LN	death
38	78	car	parking lot	victim walked behind a car that backed over victim in a parking lot	DC, LN	death
39	22 mos.	unclear	parking lot	was in the parking lot of apartments when driver backed over the child as driver was pulling out of a parking space	LN	injury
40	4	unclear	driveway	troopers said parent backed out of the driveway of a friend's home and didn't see child	LN	injury

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
41	8	car	street	was playing in a gutter when a car backed over leg	LN	injury
42	6	pickup	driveway/ street	was playing in a pile of sand in the street behind a pickup parked in a driveway - the driver came out of the home, which he had been visiting, but did not see the child and backed over child	LN	death
43	46	garbage truck	behind grocery store	victim was hospitalized in critical condition after a garbage truck backed over victim behind a grocery store	LN	injury
44	2	pickup with trailer	field	parent accidentally killed 2-year-old child when parent backed over child with a trailer	LN	death
45	2	van	driveway	2-year-old child died after parent backed over child with the family's minivan in the home's driveway	LN	death
46	3	truck	farm	3-year-old was killed Monday morning when parent accidentally backed over child with a truck	LN	death
47	19 mos.	van	driveway	parent thought child was in house accidentally backed over child in driveway	DC, LN	death
48	1	minivan	driveway	killed when backed over by a minivan	DC, LN	death
49	60	snow-plow	probably parking lot	snowplow backed over victim as victim left a store	DC, LN	death
50	7	truck	driveway	killed when parent - using plow-equipped truck - accidentally backed over child, didn't realize child was near truck when plowing driveway	DC, LN	death
51	3	unclear	driveway	parent backed over her child in the driveway	LN	injury
52	28 mos.	car	parking lot	parent buckled child into child seat, then went around car to load something, began to back out of a parking space when noticed child not in seat	DC, LN	death
53	64	auto-mobile	parking lot	pedestrian struck by reversing automobile	DC	death
54	1	vehicle	street	struck by vehicle-this was confirmed as a backing incident by FARS – point of first contact with vehicle, rear of vehicle	DC	death
55	85	vehicle	address given as location	crushed by vehicle - this was confirmed as a backing incident by FARS – point of first contact with vehicle, rear of vehicle	DC	death
56	77	car	driveway	victim struck when the car backed into victim while in own driveway - car driven by spouse	DC, LN	death
57	60	car	backyard	friend accidentally backed car into victim, pinning victim against wall of own house	DC	death
58	89	vehicle	driveway	neighbor accidentally struck victim while backing out of driveway	DC, LN	death
59	68	truck	farm	pedestrian that truck backed over	DC	death

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
60	81	recy-cling truck	street	deceased crushed by truck backing up	DC	death
61	89	truck	parking lot	truck backed over victim outside a retail business	DC, LN	death
62	91	pickup	street	was struck by a pickup truck that was backing out of parking lot, then pulled forward, running over victim again	DC	death
63	5	car	home	pedestrian backed over by vehicle (car)	DC	death
64	2	Auto-mobile	home	pedestrian backed over by automobile	DC	death
65	81	car	driveway	pedestrian struck by car backing out of driveway	DC	death
66	78	vehicle	driveway	run over while standing behind vehicle in driveway	DC	death
67	1	vehicle	home	vehicle backed over victim and struck head	DC	death
68	2	pickup	home	playing in side yard of residence - relative backed over child with a pickup	DC	death
69	1	vehicle	parking lot	hit by motor vehicle backing up	DC	death
70	3	vehicle	driveway	playing in driveway, decedent was run over by parent backing vehicle out	DC	death
71	1	car	driveway	child was backed over in driveway of home as driver was backing car into garage	DC	death
72	81	car	parking lot	victim was walking in the parking lot of grocery store, was run over by car backing out of parking space	DC	death
73	1	pickup	home	pickup backed over child	DC, LN	death
74	4	vehicle	home	child fell under a backing motor vehicle	DC	death
75	88	vehicle	driveway	victim struck by motor vehicle backing from driveway	DC	death
76	91	vehicle	parking lot	decedent was struck by a vehicle backing out of a parking space - occurred in an apartment parking lot	DC	death
77	17 mos.	car	driveway	car backed over the toddler's head	DC	death
78	41	tow truck	parking lot	tow truck backs up over pedestrian	DC	death
79	84	truck	parking lot	backed over by truck in parking lot	DC	death
80	1	vehicle	driveway	adults were distracted, child walked down street, neighbor backing out of driveway struck child	DC	death
81	82	pickup	driveway/ sidewalk	was walking down sidewalk, pickup truck was backing down driveway, did not see victim	DC	death
82	71	car	parking lot	82 yr.-old driver was backing out of parking spot, struck victim	DC	death
83	80	dump truck	unclear	victim was standing pretty far behind the truck, which backed up unaware victim was there	DC	death

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
84	1	pickup	yard of residence	victim was at the rear of the vehicle, driver backed up, hit victim, then went forward -	DC	death
85	79	car	parking lot	car was backing up from a parking space	DC	death
86	72	garbage truck	street	victim was throwing a bag of garbage into the truck, truck backed up into victim	DC, LN	
87	1	van or SUV	driveway	driver was backing out of driveway	DC	death
88	71	vehicle	field	person's vehicle backed over victim, happened in field behind person's business	DC	death
89	2	car	service station	fell out of car while backing up - occurred at service station	DC	death
90	2	pickup	at home	pickup truck was backing while victim was playing behind the truck	DC	death
91	82	auto	driveway	hit by auto in driveway - vehicle was backing out of driveway	DC	death
92	2	pickup	home	accidentally killed after crawling under parent’s pickup truck when the parent backed the truck up to go to work	DC	death
93	53	garbage truck	parking lot	backed over by garbage truck	DC	death
94	1	car	driveway	car accidentally backed up over child	DC	death
95	1	truck	home	truck backed over child's head	DC	death
96	1	car	home	backed over by passenger car	DC	death
97	62	truck	yard	deceased lying behind truck that backed over deceased, happened in yard at an address- ethanol consumption a factor,	DC	death
98	1	pickup	driveway	from ME’s office -deceased was reportedly backed over by a pickup truck	DC	death
99	77	delivery truck	alley	pedestrian struck by delivery truck in alley - was behind truck, no backup alarm referenced in report, driver didn't see victim	DC	death
100	1	van	driveway	driver of van owned by a shelter backed out of driveway and struck child	DC	death
101	1	car	driveway	accident occurred in front yard - from ME - car was backing out of driveway, child ran to left side of vehicle - left front tire ran over child	DC	death
102	1	car	parking lot	pedestrian run over by car - from ME's office - vehicle was backing	DC	death
103	2	car	home	apparently was backed over by car	DC	death
104	86	car	parking lot	driver attempting to back car out of a parking space	DC	death
105	2	vehicle	parking lot	was hit by driver backing vehicle up	DC	death
106	1	SUV	at home	spoke to police officer who remembered the incident, vehicle was backing up and it was an SUV	DC	death

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
107	17	dump truck	road repair site	deceased working as flagman on road repair job was distracted by a motorist, dump truck with no operating back-up alarm backed over deceased crushing head under the rear wheels	DC	death
108	58	dump truck	quarry	backed over by dump truck	DC	death
109	19	dump truck	highway	working on highway, dump truck backed over deceased	DC	death
110	42	dump truck	highway	struck by backing dump truck	DC, LN	death
111	34	truck	construction site	truck at construction site backed over decedent, crushing pelvis	DC	death
112	46	truck	construction site	truck backed over deceased at construction site	LN	death
113	47	dump truck	not indicated	municipal/construction foreman /victim was run over and killed by a dump truck deceased was guiding as it backed up	LN	death
114	41	dump truck	paving site	41-year-old construction worker died after an asphalt dump truck backed over worker - group of construction workers was paving part of a drive	LN	death
115	4	pickup	field	driver didn't see child relative dart behind truck as child - was backing from a field next to their house	LN	death
116	38	fuel truck	airport	killed when a truck backed into victim as victim waited to guide a jetliner to a gate, struck by a truck that had just finished fueling a departing jet	LN	death
117	35	water truck	construction site	as victim knelt down to inspect the soil, the truck driver backed over victim -	DC, LN	death
118	55	dump truck	construction site	victim run over by a dump truck - died after the truck backed over victim	DC, LN	death
119	40	pickup	median of interstate	truck's tailgate unexpectedly popped open and knocked victim down, truck's driver, was unaware victim had fallen, backed up	LN	death
120	78	dump truck	farm	dump truck backed into victim while victim was working on own farm	LN	death
121	67	dump truck	construction site	victim bent down to get some pipe when a dump truck backed over victim	LN	death
122	39	pickup	driveway	was killed when a pickup truck backed out of a driveway - truck's driver told police he did not see the pedestrian.	LN	death
123	41	truck	street/ workplace	backed over by truck	DC	death
124	55	truck	parking lot	truck backed over deceased	DC	death
125	52	farm truck	farm	was backed over by large farm truck -	DC	death
126	38	dump truck	landfill	dump truck backed over victim	DC	death
127	1	car	home	was backed over by car	DC	death
128	80	car	street in front of home	backed over by car	DC	death

#	Age	Vehicle Type	Location	Description	Source(s)	Death or Injury
129	57	plow truck	Road commission garage	plow truck backed over victim	DC	death
130	9	truck	Farm	truck backed over deceased	DC	death
131	88	pickup	parking lot	pedestrian struck by pickup truck - from police dept. - vehicle was backing up	DC	death
132	1	van	driveway	pedestrian run over by van - from ME's office - vehicle was backing up	DC	death
133	3	vehicle	driveway	from ME - child came from next door into path of vehicle backing out of driveway	DC	death

Appendix IV – Backing Deaths Identified in NHTSA's Fatality Analysis Reporting System (FARS) in Years 2000, 2001

Table XXI: 2000, 2001 Backing Deaths Identified in FARS

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
2000					
1	2, 10 (injured)	SUV	trailer park	playing children run over by truck backing up in trailer park - driver did not see children	Yes
2	16 mos.	car	driveway	driver in driveway to let off passenger and child, passenger put child down, child ran to back of vehicle, driver stuck child as driver was backing up	Yes
3	2	van	driveway	2-year-old died after was struck by a neighbor's van as it was pulling out of a driveway	Yes
4	22 mos.	small school bus	driveway	child was killed when run over by small school bus backing out of townhouse driveway, 3-yr-old sibling, & another student had just boarded bus, parent didn't know toddler had wandered away, no charges have been filed against the bus driver	Yes
5	22 mos.	car	driveway	22-month-old killed when run over, died at hospital after struck by car backing out of neighbor's driveway, was with parent and grandparent when ran down sidewalk, driver did not see the child behind vehicle, will not be charged	Yes
6	22 mos.	pickup	driveway	child was struck and killed by a pickup backing out of a driveway near child's home	Yes
7	17 mos.	unclear	parking lot	driver who backed over and killed a 17-month-old has been indicted by a state grand jury on felony charges of leaving the scene of an accident involving death.-victim was walking across the parking lot with parent	Yes

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
8	7	tow truck	street	youth was pedaling bicycle behind the tow truck in evening on a private street at a mobile-home park when the truck driver stopped and backed over youth	Yes
9	20 mos.	van	alley	toddler was killed by a hit-and-run driver - van backed over the child, who was playing in an alley - van was ditched about a block away.	Yes
10	47	dump truck	unclear	two dump trucks owned by same company, parked with rears facing each other, one backed up, struck driver of the other who was standing behind other truck	
11	75	station wagon	driveway	driver backing out of driveway, did not see victim, heard bump, pulled forward, victim on ground conscious, but incoherent, victim died 10 days later from head injury sustain in accident	
12	55	van	driveway	driver backing out of driveway, began to drive down street, wasn't driving right, got out and checked twice, ultimately found victim under the van - was admitted to hospital in critical condition and later died	
13	67	pickup	apparently street	driver stopped, heard someone call, attempted to back up too fast, lost control, drove up on sidewalk hitting pedestrian and brick wall	
14	84, 80 (injured)	pickup	sidewalk	two pedestrians were walking on sidewalk when driver backed out of driveway and struck them	
15	76	van	driveway	driver backed vehicle out of driveway, didn't realize parent was out of the house (had gone to a mailbox), struck parent who was behind vehicle at time of accident	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
16	87	pickup	driveway	driver backed out of driveway and struck victim who was blind and using a cane	
17	79	pickup	parking lot	driver backed up in public parking lot, pedestrian entered path of vehicle and was struck and run over	
18	74	light truck	unclear	truck was stopped, started to back up, struck bicyclist who came into the path of the vehicle backing up	
19	74	car	driveway	driver was backing out of driveway, didn't see pedestrian on sidewalk, felt pressure on the car, pulled forward, saw victim on the ground	
20	mos. 32	pickup	driveway	parent was backing out of driveway when child tried to get parent's attention by beating on side of passenger side of truck running toward rear of truck, got to rear of truck and fell down at which time passenger rear tire ran over victim	
21	81	SUV	parking lot/street	driver backed out of parking lot into street striking victim who was crossing the street	
22	91	car	driveway	victim was helping driver back out of driveway, driver's door was open struck victim, victim died 12 days later	
23	36	car	street	vehicle, originally in parked position, backed up and struck victim who was crossing street, victim died approximately three weeks later	
24	71	??	unclear	vehicle backed up over victim	
25	2	pickup	driveway	driver was turning around in driveway, backed up looking over right shoulder, child ran into path of truck from the left was struck by vehicle backing up	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
26	31	dump truck	unclear	no written description provided-drawing indicates truck backed up, did not realize struck pedestrian until dragging victim 61 feet	
27	90	van	apparently street	driver was backing vehicle, victim apparently stepped off curb into path of vehicle, victim was hard of hearing may not have heard beeper, van was owned by a business	
28	6	recycling truck	apparently street	truck was backing up, with beeper and rear back-up camera working (driver didn't see anything in monitor), child on bicycle, apparently looking back at friend, rode into the back of the truck, truck then ran over child	
29	3	pickup	driveway	backing out of driveway struck victim, then pulled forward not knowing what had been hit	
30	89	pickup	alley	truck was backing out of alley, struck pedestrian	
31	7	garbage truck	street	backing from one street to another, truck struck bicyclist	
32	2	SUV	driveway	victim struck as vehicle was backing out of driveway	
33	1	car	driveway	driver backing out of driveway, child playing next door ran into path of car, fell to ground near rear left wheel of vehicle, which ran over child	
34	63	van	driveway	van backing out of the driveway struck victim who was apparently in the road	
35	4, 20(injured)	station wagon	unclear	PAR on this is very sketchy, it is clear that one vehicle backed up, pinning more than one victim between it and another vehicle-seems there were three victims, one died	
36	86	car	unclear	driver backed up, did not see victim or car victim was standing next to, victim was getting into vehicle, was pinched between door and interior of vehicle	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
37	24	van	unclear	victim got out of passenger side of parked vehicle, was struck by van backing up-van left the scene	
38	70	pickup	unclear	vehicle struck victim while snowplowing	
39	40, 47 (injured)	car	apparently street	driver was backing up from gas station after dropping off friend, says she did not see pedestrians, hit them, dragged one across the street	
40	52	van	driveway	no written description - drawing indicates vehicle was backing up out of a driveway and struck pedestrian in street	
41	85	SUV	street	vehicle backing up struck victim, who from diagram apparently entered the street from between two parked cars-driver said did not see victim, did not know where victim came from	
42	70	truck	parking lot	driver was plowing parking lot, was backing up, looking both ways at traffic, struck pedestrian who was walking on the sidewalk, didn't see pedestrian	
43	43	station wagon	parking space (street)	vehicle struck pedestrian while backing into parking space, pedestrian had stepped into the street	
44	55	vehicle	street	vehicle was backing southbound in the northbound lane, driver felt bump or thud, continued to back up, saw pedestrian in front of vehicle	
45	50	van	intersection (street)	driver was backing up vehicle near intersection, felt thump, stopped car, got out saw pedestrian	
46	89	car	driveway	driver backing out of driveway, saw pedestrian in side mirror, was stopped, driver continued to back out believing pedestrian had stopped to allow driver to back out	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
47	85	car	driveway	driver backing out of driveway, struck victim who was walking on the sidewalk	
48	mos. 30	SUV	driveway	driver backing out of driveway, did not see victim	
49	66	SUV	street	driver backed up on street, struck victim who had been gardening and still had gardening blower on his back, victim died a week after the accident	
50	82	car	street	car backed down street across another street, struck victim who was in the intersection	
51	mos. 18	car	complicated scenario	vehicle was stopped by side of road, partly blocking driveway, 2nd vehicle backed out of driveway, apparently didn't look, struck 1st vehicle - child had been put outside of 1st vehicle between car and open door - 2nd vehicle struck door causing injuries to child	
52	82	pickup	driveway	driver looked behind him prior to backing straight out of the driveway between church and rectory, did not see anything behind him, but two dogs were bouncing around in back (pickup w/camper shell), did not realize struck someone	
53	68	garbage truck	roadway (street)	after finishing a collection, driver backed into roadway, struck victim-truck had rear camera system that was not turned on and when turned on had dirt over lens so would have been ineffective anyway, also back-up alarm was too faint to be heard	
54	mos. 16	car	driveway	driver backing out of driveway, checked both side mirrors and rear view mirrors, didn't see anything, struck child who had been walking on sidewalk with her older sibling	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
55	91	car	driveway	driver slowly backing out of driveway, looked both ways, proceeded, heard thump	
56	87	pickup	sidewalk	driver backed out of parking stall to enter road, as vehicle crossed sidewalk, people yelled that it had hit something, pulled back into parking spot-result - backed over victim then ran over victim again	
57	mos. 20	car	alley	car was attempting to back into an alley, driver did not see child and thought had run over a toy	
2001					
1	6	truck, probably garbage	alley	child on bike was struck by truck backing out of alleyway	Yes
2	3	pickup	probably parking lot	3-yr-old was run over and killed yesterday by a pickup that was backing out of a parking space in the townhouse development where child's family lives	Yes
3	16 mos.	car	driveway	died after parent ran over child while backing out of driveway	Yes
4	84, 80(injured)	SUV	driveway	victim was walking with neighbor around neighborhood, killed when driver backing out of driveway apparently didn't see victim and ran over victim	Yes
5	54	garbage truck	alley	disposal truck backed over a transient, who died at the scene from massive head injuries in an alley	Yes
6	39	pickup	median	pickup truck on interstate transporting furniture covered by plastic, but not tied down, sofa came off truck, driver pulled to median, ran back to pull sofa to median, victim got out of truck concerned for driver, another occupant of truck moved into driver seat, backed up truck, plastic blew up, blocked view, struck victim who originally seemed alright, but died	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
7	mos. 33	pickup	driveway??	driver, possibly backing out of driveway, struck child on bicycle, child got stuck under truck, was dragged for some distance before driver realized, removed child from under vehicle and fled	
8	67	pickup	street	driver parked in front of residence, with a passenger in the vehicle, waiting to pick up spouse, backed up in anticipating of continuing down road, heard noise, perhaps scream, got out of vehicle, saw victim lying on the ground	
9	6	vehicle	street	parent was sweeping street with the vehicle, backed up to make another pass, struck child who was behind him on a bicycle	
10	77	vehicle	unclear	driver backed up in attempt to flee from fight, lost control, struck pedestrian-charged w/DUI for refusing to take test	
11	4	van	street	parent drove vehicle out of driveway, was attempting to turn around in street in front of house, backed vehicle up and unknowingly backed over child	
12	adult	pickup	HOV lane	driver and victim were both workers on HOV lanes of an interstate highway - driver backed up vehicle in HOV lane to notify police of accident, struck victim, then went forward ran over victim again	
13	3	pickup	driveway	parent backed out of driveway, turned vehicle, did not see child approach vehicle from passenger side, vehicle struck child in area of front passenger side wheel and drove over child	
14	84	garbage truck	street	truck backing down street struck victim who was crossing the street (no crosswalk)	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
15	80	SUV	driveway	driver backed at idle speed out of driveway, had looked before started, heard thump, got out of car, noticed victim in driveway bleeding - victim had gone to mailbox.	
16	80	SUV	driveway	driver backed out of driveway at high rate of speed, did not see victim who was on a mower mowing grass	
17	82	car	curb of road (street)	driver backed up along curb of road (from diagram) and struck pedestrian, was told by people what happened, then went forward for about 50 feet, dragging victim under the car	
18	71	car	driveway	driver was backing out of driveway, looked to rear on the sidewalk and street was clear, as backed up car was having trouble backing, driver got out of car, saw pedestrian laying under trunk area of car.	
19	79	garbage truck	unclear	truck driver was backing up, checking mirrors, was watching the right side because of parked vehicle there, said never saw victim, but felt two bumps, immediately stopped and got out to find victim lying on pavement.	
20	77	car	street	driver had completed turn from shopping plaza exit to one-way street, then backed up and struck victim who was crossing the street to the shopping plaza - victim died 21 days later	
21	80	car	street	car pulled to side of street to drop off victim and groceries, passenger walked to rear of car after getting groceries out of car, driver asked victim if was okay, victim said was and it was okay to go, driver put car in reverse hit victim	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
22	17	car	street	vehicle backed out of parking lot onto one way street very fast, victim, on bicycle, was traveling on shoulder in opposite direction of one way, was struck by vehicle which also struck another vehicle, which in turn struck another	
23	7	pickup	driveway	truck, backing out of driveway, struck victim	
24	37	van	driveway	vehicle was backing out of driveway, driver said "stopped and looked both ways twice," felt bump, stopped, got out, saw victim, who had headphones on	
25	72	??	unclear	only information in report is a drawing, which makes it clear it was a backing incident, but no other details of the incident were in the report because pages were missing.	
26	63	??	driveway	no written description received, drawing indicates vehicle backed out of driveway, struck pedestrian	
27	69	truck	driveway	driver backed out of driveway to allow another car to pull out of driveway, heard thump as drove forward to return to driveway, had apparently hit victim while backing up as pattern of victim's pants was found on bumper of vehicle	
28	89	??	driveway	driver was backing out of driveway when victim walked into path, driver stopped and avoided contact, but victim fell hitting head	
29	83	van	street	driver backed up, apparently some distance (through an intersection) and struck victim who was crossing the street	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
30	68	car	roadway (street)	driver was waiting for victim to give a ride, driver saw victim walking toward the vehicle, then lost sight of victim, driver began to back up when felt vehicle hit a bump, it is not known whether or not victim fell to roadway before accident	
31	90	SUV	driveway	driver backed out of driveway into passing pedestrian	
32	43	garbage truck	street	truck was backing up in residential street, victim initially walking in street and "then suddenly darted behind" truck, which ran over victim- driver said "looked at both mirrors and the camera in the back" saw nobody	
33	20	pickup	unclear	victim had gotten out of passenger side of parked truck, was headed away from truck - driver backed up, struck victim then left the scene	
34	89	SUV	driveway	driver backed out of driveway, didn't see victim, thinks may have been behind a tree on the same side of the street from which driver was backing	
35	1	car	driveway	driver ran over victim once as backed out of driveway, again upon reentering driveway- driver said thought had gone over the curb	
36	mos. 17, 4, 21 - 4 and 21 year olds injured	vehicle	driveway	vehicle backing out of driveway, in dark, street lights were flickering on and off, hit three pedestrians, youngest of whom was seriously injured and died	
37	mos. 22	car	driveway	backing out of driveway, looked, saw adult clear driveway, struck child	
38	47	SUV	unclear	backing up to enter vacant parking space, heard a thump, struck pedestrian	
39	67	van	street	vehicle backing up on street struck pedestrian	

#	Age(s)	Vehicle Type	Location	Description	Found in LexisNexis™
40	4, 3 other victims, age unknown - injured	vehicle	apparently street	vehicle was backing up, 2nd vehicle double parked with no vehicle between it and curb, 1st vehicle struck driver door of 2nd pinning person getting into, then struck three pedestrians who were attempting to enter 2nd vehicle and were crossing street	
41	50	pickup	road shoulder	guy pulled in front of disabled car on shoulder, offered to help, started to back up, struck victim, driver fled scene, victim had blood alcohol content of .08	
42	mos. 18	SUV	driveway	parent was backing vehicle out of driveway when did not notice that child had moved from the front area of the vehicle to the rear driver's side area of the vehicle, he struck child - end point of the incident was the sidewalk area	
43	mos. 13	van	driveway	victim & 6-yr old cousin were playing in closed garage, parent opened garage door, went to van parked in street, started to back van into driveway, didn't realize victim had followed parent out of garage, left front wheel ran over victim.	
44	95	car	driveway	driver backing out of driveway struck victim who was apparently on sidewalk, report suggests victim was dragged 59 feet before vehicle stopped	
45	70	car	intersection (street)	occurred at intersection, victim & friend were standing on SE corner, started to cross, struck by driver's side front quarter panel of vehicle as driver attempted to back vehicle into the intersection	

Appendix V - Summaries Of and Data From Articles On Deaths and Injuries From Vehicles Backing Up

A review of research articles dealing directly with or indirectly touching on the issue of persons injured or killed as a result of being struck by a vehicle backing up identified several distinct trends relating to backing incidents. Backing incidents tend to:

- Occur in residential driveways and parking lots,
- Involve sport utility vehicles (SUVs) or small trucks,
- Occur when a parent, relative or someone known to the family is driving, and
- Particularly affect children less than five years old.

Brison RJ, Wicklund K, Mueller BA. *Fatal pedestrian injuries to young children: a different pattern of injury*. Am J Public Health 1988 Jul;78(7):793-5.

This research examined Washington State death certificates from 1979-83 with ICD 9 E-Codes 814-825 (motor vehicle-related incidents) indicated as the cause of death. This study also reviewed coroners' reports when needed and if such a report was available as well as police reports if necessary to obtain details of the incidents involved.

The study identified 71 fatal motor vehicle injuries to children less than five years of age during the five-year study period. Of these, 41 were found to be non-traffic related, with 30 incidents occurring in driveways and 11 having occurred in apartment or store parking lots.

The projected average annual death rate data presented in this study show that all of the non-traffic deaths involved children between the ages of 1 and 4. That data appear in the following chart:

Table XXII: (from Brison, et. al.) Average Annual Death Rates by Age and Sex of Child for Non-Traffic and Traffic-Related Pedestrian Incidents

	Non-traffic		Traffic	
Age (years)	**Number**	**Rate/100,000 population**	**Number**	**Rate/100,000 population**
0	0	--	2	0.6
1	19	5.8	7	2.2
2	11	3.4	4	1.2
3	7	2.2	10	3.1
4	4	1.2	7	2.2
1-4	41	3.2	28	2.2
Male	25	3.8	16	2.4
Female	16	2.5	14	2.2

The propensity for SUVs or small trucks to be involved in non-traffic incidents as well as for a parent or family member to be driving is demonstrated in the following data that was presented in this study.

Table XXIIIII: (from Brison, et. al.) Characteristics of Non-Traffic and Traffic-Related Pedestrian Vehicle Collisions to Children Less than Age Five

Characteristics	Non-traffic	Traffic
Vehicle Type		
Light Truck	16	1
4 x 4 Truck or Jeep	6	0
Van	6	3
Passenger Auto	9	25
Vehicle Direction		
Forward	9	29
Reverse	23	1
Fell/Jump from vehicle	3	0
Driver		
Father	10	0
Mother	4	0
Other family or visiting friend	6	0
Other	8	27

Winn DG, Agran PF, Castillo DN. *Pedestrian injuries to children younger than 5 years of age*. Pediatrics 1991 Oct;88(4):776-82.

Similar results were found in this study that examined the differences in pedestrian injuries between toddlers (children two years old and younger) and preschoolers (children three and four years old). The study found that toddlers more often die in non-traffic accidents than do preschoolers and it confirmed that children aged one to four are the ones most affected by driveway incidents. "In the entire sample of child pedestrians 0 through 14 years of age, all of the hospital admissions for driveway related events involved children younger than 5 years of age and all of the fatalities were younger than 2 years of age," the study reported.

This study was based on data derived from a hospital-based monitoring system of motor vehicle-related injuries to children in Orange County, CA over a two-year period (April 1987 through March 1989). The monitoring system includes 9 of 38 hospitals in the county as well as the coroner's office. The sample examined in this study included 67 toddlers and 102 preschoolers either injured or killed in non-traffic events. Backing was the vehicle action most common among incidents involving toddlers, accounting for 32 or 57 percent of the incidents reviewed. In incidents involving preschoolers, on the other hand, backing was the vehicle action in only 13 or 17 percent of the cases. The data relating to this issue appear below.

Table XXIV: (from Winn et. al.) Action of Vehicles Involved in Non-traffic Accidents Involving Toddlers and Preschoolers

Characteristic	Toddlers (n=67)	Preschoolers (n=102)
Action of vehicle	No. (% of total)	No. (% of total)
Turning	2 (4)	6 (8)
Traveling Straight	22 (39)	57 (75)
Backing	32 (57)	13 (17)
Not ascertained	11	26

The majority of the vehicles involved in the 169 non-traffic events included in this study were automobiles, 35 or 71 percent of the incidents involving toddlers and 52 or 74 percent of the incidents involving preschoolers.

Of the 10 fatalities identified in the study, six involved toddlers and all of those involved a vehicle backing up. Four of these six incidents involved a van or pickup truck and five of the six incidents occurred in a driveway. All of the four deaths of preschoolers occurred mid-block and involved a vehicle (three cars, one motorcycle) proceeding straight.

In addition to the 6 toddler and 4 preschooler deaths, the study identified 27 toddlers (40 percent) who required emergency department treatment only and 34 (51 percent) who were hospitalized. Some 44 (43 percent) of the preschoolers required emergency department treatment only and 54 (54 percent) required hospitalization.

Agran PF, Winn DG, Anderson CL. *Differences in child pedestrian injury events by location.* Pediatrics 1994 Feb;93(2):284-8.

This research compared "child pedestrian injury events occurring in driveways and parking lots and at mid-block and intersections with respect to the characteristics and activity of the child, injury outcome measures, and characteristics of the vehicle and roadway."

Data for this study were derived from a large multi-hospital and coroner monitoring system for motor vehicle-related injuries to children in Orange County, CA. Data in the study cover the two-year period, April 1, 1987 through March 31, 1989. The sample consisted of 345 child pedestrians 0 to 14 years of age, who were injured during this period.

With respect to non-traffic events, the study found:

- 40 percent of the drivers involved in non-traffic events were driving vans, trucks, or four-wheel drive vehicles; most of these were backing up.
- Most of the children struck were under five years of age.
- Almost half were with adults at the time of the incident.
- The majority of those injured in non-traffic events sustained minor head injuries, but 8 percent of those in driveways sustained non-survivable head injuries, which was a much higher percentage than those injured at other locations.

Some of the data presented in the article and that supports these observations follow.

Table XXV: (from Agran et. al.) Location of Pedestrian Injury Events (N=345)

Location	N (%)
Midblock	182 (53)
Intersection	95 (28)
Driveway	39 (11)
Parking lot*	29 (8)

**The authors of the study found, "The results for events occurring in parking lots were similar to the driveway events."*

Table XXVI: (from Agran et. al.) Movement and Type of Vehicle That Struck Pedestrian by Location of Injury, for Four Major Location Types

	Driveway (N=39) n(%)	Parking Lot (N=29) n(%)	Midblock (N=182) n(%)	Intersection (N=95) n(%)
Movement				
Backing	28(78)	16(59)	6(3)	…
Forward	6(17)	10(37)	162(93)	61(72)
Turning	2(6)	1(4)	6(3)	24(28)
Unknown	3	2	8	10
Type of vehicle				
Van, truck, pickup & 4-wheel drive	13(41)	11(39)	42(24)	17(19)
Passenger car	19(59)	17(61)	134(76)	71(81)
Unknown	7	1	6	7

Table XXVII: (from Agran et. al.) Gender and Age of Pedestrians by Location of Injury, for Four Major Location Types

	Driveway (N=39) n(%)	Parking Lot (N=29) n(%)	Midblock (N=182) n(%)	Intersection (N=95) n(%)
Gender				
Female	10(26)	7(24)	48(26)	40(42)
Male	29(74)	22(76)	134(74)	55(58)
Age in years				
0-2	22(56)	7(24)	17(9)	0(0)
3-4	8(21)	9(31)	42(23)	8(8)
5-9	5(13)	4(14)	87(48)	34(36)
10-14	4(10)	9(31)	36(20)	53(56)

Table XXVIII: (from Agran et. al.) Companions by Location of Injury, for Four Major Types

	Driveway (N=39) n(%)	Parking Lot (N=29) n(%)	Midblock (N=182) n(%)	Intersection (N=95) n(%)
Companions				
With adults	14(45)	14(50)	41(23)	21(24)
With other children	11(36)	13(46)	101(57)	43(49)
Alone	6(19)	1(4)	34(19)	23(26)
Unknown	8	1	6	8

Table XXIX: (from Agran et. al.) Disposition by Location of Injury for Four Major Location Types

	Driveway (N=39) n(%)	Parking Lot (N=29) n(%)	Midblock (N=182) n(%)	Intersection (N=95) n(%)
Fatality	4(10)	…	8(4)	4(4)
Admitted to hospital and discharged home	15(38)	11(38)	103(57)	50(53)
Treated in emergency department and released	20(51)	18(62)	71(39)	41(33)

Duhaime AC, Eppley M, Marguilies S, Heher KL, Bartlett SP. *Crush injuries to the head in children.* Neurosurgery 1995 Sept;37(3):401-6.

While the focus of this article was on the clinical and treatment aspects of dealing with crush injuries to a child's head, it was nonetheless interesting and noteworthy for this NHTSA research effort that of the seven cases chosen to be reported in this article, four involved a child's head being run over by a motor vehicle backing up in a driveway or parking lot. Of these cases, three involved oversized vehicles --one van, one truck, and one small bus. One involved a car. The article does not indicate the years in which the cases occurred.

Partrick BA, Bensard DD, Moore EE, Partington MD, Karrer FM. *Driveway crush injuries in young children: a highly lethal, devastating, and potentially preventable event.* J Pediat Surg 1998 Nov;33(11):1712-5.

This study was based on a six-year review (1991 to 1996) of child (less than 18 years of age) pedestrian injuries treated at two urban trauma centers. In the study sample of 527 children who as pedestrians were injured by automobiles, the authors found 51 (9.7%) incidents that were driveway-related and in which the car rolled backwards over the child. Children under five made up the majority of the driveway cases (41 of 51, 80%). Six driveway cases involved children between the ages of five and nine. Four cases involved children older than nine. Of the children who died as a result of a driveway incident, all were in the 0 to 4 age group.

As with other studies discussed here, this study considered who was driving the vehicle in driveway incidents. A parent was the driver in at least 14 (34%) of the driveway rollover accidents. Siblings were the drivers in four cases (10%), a grandmother in one incident (2%), and neighbors in three (7%) incidents. The person driving the vehicle was not specified in 19 incidents.

Silen ML, Kokoska ER, Fendya DG, Kurkchubasche AG, Weber TR, Tracy TF. *Rollover injuries in residential driveways: age-related patterns of injury.* Pediatrics 1999 Jul;104(1):e7.

This research addressed rollover injuries in driveways and age-related patterns involved. From the medical records of 3,971 consecutive admissions to a single urban trauma service between March 1990 and October 1994, the authors found 26 children (0.7%) who sustained rollover injuries caused by a motor vehicle in a residential driveway. Eighteen (69%) of these injures occurred as the result of the child being struck by an adult driver in a vehicle backing up. The other 8 incidents involved either a sibling under the age of 16 rolling over the child (n=4) or the child putting the vehicle in gear then attempting to get out of the vehicle (n=4). Two of the children died as a result of their injuries and were excluded from the remainder of the study. Nineteen of the 24 survivors in this study were less than 5 years old. The study also determined that younger children were more likely to sustain more severe injuries as a result of these incidents, particularly those less than two years old.

Nadler EP, Courcoulas AP, Gardner MJ, Ford HR. *Driveway injuries in children: risk factors, morbidity, and mortality*. Pediatrics 2001 Aug: 108(2):326-8.

A study published in 2001 by Nadler et. al. focused on a cohort of 64 patients admitted to the Children's Hospital of Pittsburgh after having sustained motor vehicle-related injuries in a driveway. This cohort was derived from a total of 9,820 patients admitted to the hospital's trauma program between May 1986 and August 1999. The cohort was divided into two groups based on the types of events in which they were involved. Group 1 involved an adult driver striking a child because he or she was unaware of the child's presence. Group 2 consisted of children who were injured by a vehicle set in motion by a child. More than 85 percent of the incidents included in Group 1 involved a vehicle going in reverse.

The findings of this study are consistent with those previously discussed with respect to the age of the children most affected by backing incidents in driveways (less than 5 years old) and the types of vehicles involved (more often an SUV or truck). Data supporting this presented in the study appear below.

Table XXX: (from Nadler et. al.) Age Distribution of Children Injured in Driveway Related Accidents and Types of Vehicles Involved

	Total (n=64)	Group 1 (n=44)	Group 2 (n=20)	
Age in yrs (mean)				
<2		19 (43%)	3 (15%)	
2-5		22 (50%)	9 (45%)	
>5		3 (7%)	8 (40%)	
Type of vehicle				
SUV or truck	31	28	3	
Car	26	16	10	
Not available	7	0	7	

Di Scala C, Sege R, Guohua L. *Outcomes of Pediatric Pedestrian Injuries By Locations of Event.* 45th Annual Proceedings, Association for the Advancement of Automotive Medicine, Sept. 24-26, 2001.

This study by DiScala, et. al. focused on medical outcomes of pediatric pedestrian victims of motor vehicle accidents based on the location where the accident occurs. Data presented in this article relate entirely to the location of the incident. No data specific to backing incidents were presented. However, based on the review of the data involved, the following statement was made in the article with respect to incidents that occur in driveways, "Typically, a very young child is playing in the driveway, and is run over by a family member or a visiting friend reversing a vehicle out of a home driveway."

***Nonoccupant Fatalities Associated With Backing Crashes*. Research Note, *Revised* February 1997, National Highway Traffic Safety Administration.**

The principal investigator involved in preparing this note retired from the agency several years ago. It was therefore not possible for the researchers involved in this report to clarify the methodology used in generating the data that are presented in this research note. The research note is based on 1992 and 1993 death certificate data from the National Center for Health Statistics (NCHS) and on traffic fatality data from police reports contained in NHTSA's Fatality Analysis Reporting System (FARS). The research note reports that data from these two sources "were used to obtain average annual estimates of the number of fatalities associated with off-road and on-road fatal backing crashes." The note makes clear, "Due to the lack of detailed information on death certificates (the source of NCHS data), it is not possible to determine the exact number of nonoccupants killed in off-road backing crashes. The NCHS data, therefore, provide an estimate of the maximum number of fatalities associated with these crashes."

Data presented in this research note confirm one of the patterns associated with backing fatalities that was identified in the research on which this report is based. The research note found that children ages 1-4 are particularly affected by backing crashes. The numbers presented in the note, however, are higher than were found either in counts made as part of the research done for this report or in projections of annual national totals based on those counts.

The disparity between the numbers presented in this report and those in this research note is likely rooted in the fact that different approaches were taken in the two research efforts. Those

who did the work for the research note seemed to be addressing the question, "What is the maximum possible number of backing deaths that could be occurring annually based on NCHS death certificate and FARS data?" This may have caused those working on the research note to make certain assumptions concerning the data that were used to determine the maximum possible number of backing fatalities. On the other hand, the goal of those who did the work on which this report is based was to simply count the number of backing (and other) incidents that occur in a given time period and that can be verified through various sources. There may be additional backing incidents that occurred in 1998, for example, the year that was the focus of death certificate research for this report, but only the incidents reflected in the counts presented in this report could be identified or verified.

In addition to the different research approaches, some of the disparity may result from the fact that the data used for the research note were from 1992 and 1993 while the years covered in this report are 1998 and later.

Data presented in the research note appear below.

Table XXXI: (from NHTSA Research Note) Annual Estimates of Nonoccupant Fatalities in Off-Road Backing Crashes – 1992-1993 Average

Age Group	# of Fatalities	% of Total	% of Population
1-4	116	30	6
All Other Ages	274	70	94
Total	390	100	100

Table XXXII: (from NHTSA Research Note) Annual Number of Nonoccupant Fatalities in On-Road Backing Crashes – 1992-1993 Average

Age Group	Number of Fatalities	% of Total
1-4	14	16
All Other Ages	71	84
Total	85	100

Appendix VI – Backing Injury Data

The National Electronic Injury Surveillance System (NEISS)

The following table presents data derived from an examination of the National Electronic Injury Surveillance System (NEISS) of the Consumer Product Safety Commission.

Table XXXIIIII: Injuries from Backing Incidents --National Projections Based on NEISS Data from July 1, 2000 – June 30, 2001

Age	<1	1-4	5-12	13-21	22-64	>64	All
Total (a)	125(a) (1 case)	1101	1089	1111 (a) (18 cases)	2394	860 (a) (13 cases)	6680
Disposition							
1	125 (a) (1 case)	483 (a) (16 cases)	1042	1086 (a) (17 cases)	2337	669 (a) (9 cases)	5742
2	--	--	--	--	--	28 (a) (1 case)	28
4	--	499 (a) (13 cases)	46 (a) (3 cases)	25 (a) (1 case)	56 (a) (2 cases)	161 (a) (3 cases)	787
8	--	118 (a) (1 case)					118
Total (a)	125 (a) (1 case)	1100	1088	1111 (a)	2393	858 (a) (13 cases)	6675

Any differences in totals result from rounding of national projections to the lowest whole number

(a) *– Number of incidents found was below 20, which limits the reliability of the national projection*

1 *– Treated and released, or examined and released without treatment*

2 *- Treated and transferred to another hospital*

4 *– Treated and admitted for hospitalization (within same facility)*

8 *– Fatality including DOA*

Backing Injuries in the General Estimates System

The following chart presents data on backing injuries derived from the National Highway Traffic Safety Administration's General Estimates System (GES).

Table XXXIV: Backing Incidents: Annualized GES National Estimates 1996-2000

	Leaving Parked Position	Entering Parked Position	Backing up (not parking)	Total ↔	No Injury	Possible Injury	Non incapacitating evident injury	Incapacitating injury	Fatal Injury	Unknown
Car	21.173	78.868	1248.4	1348.4	63.726	701.78	398.22	110.71	20.523	53.455
SUV	0	4.6268	158.92	163.55	0	51.437	42.408	69.703	0	0
Van	0	5	394	399	127.98	142.57	96.611	27.401	4.4368	0
Lt. Truck	9.0428	0	99.631	108.67	0	0	54.768	44.186	4.4928	5.2268
Other Lt. Veh.	0	53.11	133.5	186.61	0	157.64	5.6961	23.277	0	0
Single unit straight truck	0	0	40.343	40.343	0	14.862	16.153	4.8076	4.52	0
Truck-tractor cab only	0	0	6.8024	6.8024	0	4.484	2.3184	0	0	0
Unknown med./heavy Truck type	0	0	14.211	14.211	0	0	0	0	14.211	0
Other body type	0	0	43.514	43.514	0	0	38.706	4.8076	0	0
Unknown body type	0	0	79.148	79.148	0	59.386	19.762	0	0	0
Total	30.2158	141.6048	2218.4694	2390*	191.706	1132.159	674.6425	284.8922	48.1836	58.6818

**Rounded to the nearest whole number to reflect slight differences that occur in calculating the total using the various figures available for that calculation.*

National Hospital Ambulatory Medical Care Survey – Data From Emergency Departments

The 2000 NHAMCS file for emergency department visits contains 25,622 records, 8,791 of which are for unintentional injuries. The text fields of the unintentional injury records were searched for certain words that would likely be used in describing one of the types of non-traffic motor vehicle-related incidents under study.

A total of five incidents involving a vehicle backing up were found in the NHAMCS emergency department file. Details of those incidents are provided below.

Table XXXV: Vehicle Backing Incidents Located In The 2000 NHAMCS (Emergency Department) File

Description	Patient Weight*
Walking across street and struck at low speed by a car backing up	2,041
MVC, truck backed into parked car	3,088
Passenger, restrained, car backed into their car and pushed their car back 5 feet	11,698
Jogging and ran into car that was backing up	4,302
Fell at 3 a.m. when she was standing behind her car and truck backed into her car which then pushed her	3,005

**When there are 30 or more similar incidents, the patient weights for all of the incidents can be added to together to create a projection of the national total of such incidents. The patient weights presented here are for information purposes only. They are of little or no predictive value since they each represent only one incident. Even if the incidents are considered to be similar, there are still only five such incidents here so no reliable predictions as to the national total of such incidents can be made.*

Appendix VII – Passenger Compartment Vehicle Heat Deaths Found in 1998 Death Certificates

Some of the descriptions of passenger compartment vehicle heat deaths in the table below are supplemented by information contained in news accounts found in LexisNexis™.

Table XXXVI: Passenger Compartment Vehicle Heat Deaths Found in 1998 Death Certificates

#	Age	Description
1	9 mos.	left strapped in child safety seat in a sweltering minivan for two hours - misunderstanding between child's parents resulted in the child being left alone in the van; one parent believed infant was at home with other
2	8 mos.	left in car - died of hyperthermia
3	6 mos.	child's parent had just returned from picking up victim and other children from the baby sitter - wasn't until an hour later, when other parent returned home, that they discovered child still inside car
4	6 mos.	baby died when accidentally left in hot car for 3 hrs, died when outside 90-degree temperatures rose to 130 degrees inside closed car, parents thought the other had carried the baby from the car to crib
5	34 mos.	toddler who recently learned how to open a car door apparently climbed inside family station wagon while parent and sibling were in house
6	23 mos.	relative babysitting child, put child in car for trip to store, went back in house having forgotten something, was distracted by something on television, sat on couch to watch, fell asleep, woke up two hours later
7	21 mos.	parents apparently forgot to remove child from car previous night
8	79	probable hyperthermia-exposure to heat inside vehicle
9	53	went outside to smoke accompanied by staff member of residential facility, missed dinner, employees searched van and found victim inside, doors were locked and windows were rolled up
10	51	exposed to extreme temperatures while in private vehicle - cause of death-hyperthermia, chronic ethanol abuse & emphysema
11	46	sleeping in closed van while intoxicated
12	45	hyperthermia - acute ethanol intoxication - happened in parked car
13	4	hyperthermia - left child in car - place of injury - child care center
14	4	found unconscious in closed vehicle - temp over 90 degrees
15	39	Exposure to desert heat in a vehicle without air conditioning - place of injury - automobile on highway
16	3	day care center workers overlooked a 3-year-old child who died of heat exhaustion after being accidentally locked in a van and left in the 95-degree heat for three hours
17	3	investigators believe victim could not escape because the car's rear door "child- proof" safety locks were engaged
18	2	found inside vehicle parked outside residence in 95-degree heat
19	2	parent left child in car after returning home from errand - was left for more than an hour
20	2	child apparently slipped away from parents and siblings, fell asleep atop blanket in unlocked car in driveway of home, oldest sibling found child 40 minutes later

#	Age	Description
21	2	siblings and parent were cooling off in a backyard pool when victim wandered out to the van, climbed in through an open door and got stuck when the door slid shut
22	2	found inside the car in extremely hot temperatures - place of injury – driveway

Appendix VIII - Summaries Of Articles On Power Window Deaths

Simmons GT. *Death by power car window. An unrecognized hazard.* Am J Forensic Med Pathol 1992 Jun;13(2):112-4.

The case reported here was unusual in that it occurred while the vehicle was being driven. Also, those who investigated the case concluded that the power window was apparently activated by the driver of the vehicle rather than the child who died. The victim, a 26-month old child, was in the rear of an early 80s model passenger car being driven by an elderly relative. When the driver arrived at her destination, she found the child caught in a rear power window. The police determined that the position of the switch for the power window and the measurements of the child made it extremely unlikely that the child had activated the switch, although apparently the child might have done so by using her foot. Only the possibility that the child intentionally activated the switch with her hand is addressed and discounted in the article. There is no discussion as to whether or not the child might have inadvertently done so with her foot.

Strauss RH, Thompson JE, Macasaet A. *Accidental strangulation by a motor vehicle window.* Pediatr Emerg Care 1997 Oct;13(5):345-6.

The victim in the case reported here was a four year nine months old child. She was in the back seat of an early 90s model pickup truck with two siblings, one three years old, the other one year old. The vehicle was left running with the heater on while the driver (father) went into a neighbor's house. Five minutes later the victim was found trapped in the front seat passenger side power window. The author of this case report concluded that it was most likely that the victim or the three-year-old sibling activated the power window and neither was able to lower the window.

***Injuries Associated With Hazards Involving Motor Vehicle Power Windows*. Research Note, May 1997, National Highway Traffic Safety Administration.**

Under an agreement between NHTSA and the Consumer Product Safety Commission (CPSC), the CPSC identified incidents from its National Electronic Injury Surveillance System (NEISS) in which injuries occurred as a result of several types of motor vehicle hazards, including motor vehicle power windows. NEISS is based on a representative sample of hospitals that provide emergency care on a 24-hour basis. A total of 10 incidents of injuries from power windows were found in the 12-month period, October 1, 1993 –September 30, 1994. These incidents project to an estimated 499 persons who were injured nationwide during this time. Most of the injuries were to the hand, wrist or finger. All of the injuries were either "minor" or "moderate." Most – 64 percent of the injuries – were to children 14 years old or younger, with 32% of the injuries to children 6-14 years of age and 32% of the injuries to children 0-5 years of age.