ORIGINAL ARTICLE

Heat related deaths to young children in parked cars: an analysis of 171 fatalities in the United States, 1995–2002

A Guard, S S Gallagher

Injury Prevention 2005;**11**:33–37. doi: 10.1136/ip.2003.004044

See end of article for authors' affiliations

Correspondence to: Ms Anara Guard, Education Development Center, Inc, 55 Chapel Street, Newton, MA 02458-1060, USA; aguard@edc.org

Objective: To describe the circumstances surrounding heat related deaths to young children in passenger compartments of motor vehicles.

Methods: Cases of heat related deaths to children aged ⩽5 years confined in parked vehicles were retrospectively identified using online news accounts from 1 January 1995 to 31 December 2002. A standardized data form was developed to collect information related to the victim, the vehicle and its design features, external temperature, length of time confined, and the responsible adults. Cases were categorized by whether the child gained access to the vehicle or was left by adults.

Results: A total of 171 fatalities that met the case criteria were identified. Twenty seven percent (46) were children who gained access to unlocked vehicles and 73% (125) were children who were left by adults. More than a quarter of the adults were aware they were leaving children in the vehicles, while half were unaware or forgot. Forty three percent (54) of deaths to children who were left were associated with childcare: 32 children were left by family members who intended to take them to childcare but forgot and went to work instead; 22 children were left by child care providers or drivers.

Conclusions: Many of the deaths reported in this study may have been prevented by keeping cars locked, educating parents, implementing informed child care transportation policies, passing relevant laws, and working with auto and child safety seat manufacturers to build in warnings and other design features. News sources can be useful for obtaining detailed information not otherwise identifiable through standard sources of fatality data.

Each year, an unknown number of young children die in the United States of heat stroke from being enclosed in parked motor vehicles. Physicians in the United States, Great Britain, and New Zealand warned about the risks of leaving infants and toddlers in hot cars in 1976 and in the early 1980s.[1–5] Medline contains only a few examples of more recent literature on this topic or on the vulnerability of young children to heat.[6–9] A 2002 report of injuries to unattended children in or around vehicles listed heat related causes as the most common type of fatality.[10] A National Highway Traffic Safety Administration (NHTSA) study of death certificates of certain non-traffic and non-crash events found 24 heat related deaths in 1998, 23 to children under age 5.[11]

There are no unique codes to identify motor vehicle heat related deaths in the *International Classification of Diseases* (ICD) or in any United States national or state data source. The WONDER and WISQARS (Web-based Injury Statistics Query and Reporting System) databases of the Centers for Disease Control and Prevention can be searched by relevant ICD-9 E codes (E900, excessive heat and its subcodes; E904.0, abandonment, and E904.3, exposure) but do not specify whether the decedents were in a vehicle. Fatality Analysis Reporting System (FARS) data from NHTSA are limited to deaths that occur as a result of a traffic crash.[12] We sought to describe the circumstances of heat related fatalities to children in the passenger compartments of parked vehicles by using news accounts as our primary source of information.

METHOD

Previous investigators have described the value of using news sources for injury surveillance.[13–16] Ideally, news accounts supplement other data, but with no national datasets for this cause of death, news became our primary source. A professional librarian searched for incidents occurring between 1 January 1995 and 31 December 2002, using newspaper indexes, news websites, and internet search engines.[17] Keywords related to children, heat, motor vehicles, abandonment, enclosure, death, and injuries were used. Cases were defined as children aged ⩽5 years who died from heat related causes while confined in the passenger compartment of a parked motor vehicle in the United States.

A modified ''snowball technique'' tried to identify additional cases and to gather more detail. News accounts often referred to prior incidents, which we then sought. On several occasions, reporters contacted us and we identified new incidents or more details as a result. Queries seeking cases were sent to email discussion lists focusing on injury prevention, child death review, and child abuse.[18] All these sources were supplemental; standard news accounts were required for each case to meet our criteria.

For each identified case, we created a unique record in a Filemaker Pro database. Multiple local news sources were searched for each case to verify details, reconcile inconsistencies reported in earlier accounts and track developments. Table 1 shows the study variables grouped by victim, vehicle, and other factors.

Cases were grouped and analyzed by *incident*: one or more children dying in a vehicle as a result of heat. Incidents were assigned mutually exclusive categories relating to the circumstances in which the victims were in the vehicles: *playing* or *left unattended*. We also looked at whether the adults knew when they exited the vehicle that they were leaving a child behind.

Abbreviations: ICD, *International Classification of Diseases*; NASA, National Aeronautics and Space Administration; NHTSA, National Highway Traffic Safety Administration

Table 1 Study variables

Victim factors	Vehicle factors	Circumstance factors
Age	Make	*Town or city*
Cause of death related to heat	Model	*State*
Gender	Year	*Date*
Child's name	Color	*Responsible person and relationship to victim* (for example, self, mother, foster parent, daycare provider)
Prior existing health problems	Location (for example, parking lot, driveway)	Length of time in vehicle
Victim's activity at time of incident (playing, sleeping)	Design features (for example, tinted windows, electric door locks)	Temperature high for date
Presence of other children in the vehicle	Other factors (for example, vehicle was abandoned)	Time of day of incident
Outcome for other children	Use of child safety seat	Adult's activity (for example, shopping, working)
		Intention of adult (forgot, left child intentionally)
		Adult use of alcohol or other drugs
		Legal consequences
		Adult's age
		Adult gender
		Other factors (for example, marginal housing, family event)
		Prior involvement with child protection agencies

Italics indicate information required to meet case criteria.

RESULTS

As of 31 December 2002, the database contained information on 233 heat related deaths to children in parked motor vehicles. Although this study focuses on the United States, deaths were also identified in Australia (6), Japan (4), England (2), Israel (2), Italy (1), and Malaysia (1).

A total of 171 deaths comprising 159 incidents met the case criteria (box 1).

In 10 incidents, two children died in each vehicle, and in one incident, three died. Forty six children (27%) died while playing and 125 children (73%) died when left unattended.

The children's ages ranged from 10 days to 4 years; almost two thirds (64%) were male. The mode for girls was <6 months old, while for boys it was 2–2.5 years (table 2).

We grouped the circumstances by children who gained access while playing (27%) and by those left by adults (73%), which further divided into forgotten, left intentionally, and unclear intentions (fig 1).

High temperatures ranged from 63 to 115° F. Three quarters of incidents (124 of 159) were during the summer months of June, July, and August. There were no patterns to the number of deaths each year, ranging from seven in 1996 to 30 in 1999. Incidents occurred in 41 of 50 states (fig 2).

Most reports estimated how much time elapsed from when the child was last seen or placed in the car to when the child was found. The estimates ranged from less than 15 minutes to 10 hours; one child's body was not found for several days. Eighty two percent (140/171) of children were in the vehicle for ⩾1 hour, and 29% (50/171) were in the vehicle for ⩾5 hours. A larger percentage of girls (39%) than boys (24%) were enclosed for ⩾5 hours.

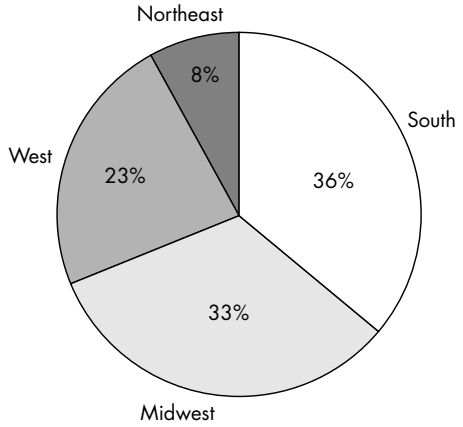

Figure 2 Geographic distribution.

Circumstances: children playing

Twenty seven percent of deaths (46/171) were children who gained access to unlocked vehicles, most (35) in the family's own vehicle at home. Seven incidents (11 victims) occurred

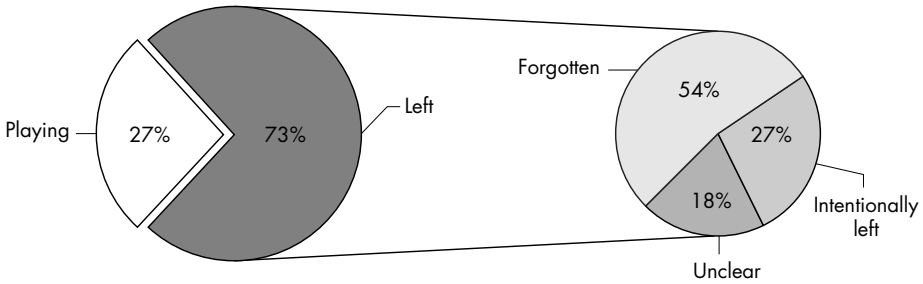

Figure 1 Circumstances.

Box 1: Case criteria exclusions

233 apparent heat related deaths to children

- 22 trunk entrapment deaths
- 16 deaths outside the United States
- 4 deaths to children >5 years
- 20 deaths unconfirmed as heat related

171 deaths in analysis

in other vehicles in the neighborhood, mostly abandoned cars. Children who died while playing in vehicles tended to be boys (78%), between 2 and 3 years old (48%), and often were with other children who did not enter the vehicle. More than one third of children who died while playing were in the vehicle for less than one hour; three were thought to be in the vehicle for less than 15 minutes. In five incidents, there were multiple deaths: four pairs of children (including two sets of twins), and one vehicle containing three children.

In one fourth (10/41) of the playing incidents, the adults were napping or showering when the children entered the vehicle. Three accounts reported that families told investigators the child had previously entered the vehicle, or had just recently learned to open the car door. In four incidents, the children were sought for hours before the vehicle was searched.

Circumstances: left unattended

Seventy three percent of deaths (125) occurred when adults left children unattended in vehicles. Unattended children tended to be younger than children who died while playing: more than half (64) were ⩽1 year. Three fifths (74) of unattended children were boys. We identified 137 adults responsible for leaving children (in six cases, two adults were involved): 83 women and 52 men. In two cases, the adults' genders are unknown.

Just over half (68/125) of unattended deaths occurred when adults forgot or were unaware of the child. Thirteen of these involved a change in routine—a large family gathering (often around the Fourth of July), move, or other upheaval.

Twenty seven percent (34) were deliberately left in vehicles by adults who were aware that they were doing so. Some adults were reluctant to disturb a sleeping child and failed to realize how hot the vehicle would become. In other incidents, the car—and the child safety seat—were used to restrain the child so the adults could sleep, work, drink or use drugs, or gamble. Twelve children were left for ⩾5 hours, seven for ⩾8 hours.

In 12 incidents involving 15 children, the responsible adult had a documented history of problems with alcohol or other drugs or mental illness. Three children were left behind by adults reportedly too intoxicated to notice the child.

Almost half (56) of unattended deaths were associated with child care. Twenty four children (19%) were left by child care providers, drivers, or babysitters, most of whom were formal or licensed providers. Thirteen of these victims were left in child care vans or school buses. Another 32 children were left by adults who meant to transport them to child care but went to work instead. Usually, the children were not found until the parent returned to the vehicle at the end of the day, or the other parent went to retrieve the child from child care.

The vehicles

Sport utility vehicles, vans, and minivans accounted for 33% (57/171) of the vehicles. At least 16 vehicles had tinted windows which may have prevented the victims from being seen. In some instances, electric door locks and heavy sliding doors kept children from exiting, even when they had been able to enter the vehicles. Nine vehicles were inoperable or abandoned. Although news accounts did not consistently mention child restraints, 45% (77/171) of the victims were noted as being found in child safety seats.

Table 2 Deaths by age groupings

Age (months)	Girls % (n = 61)	Boys % (n = 110)	Total (n = 171)
0–11	41 (25)	31 (34)	34 (59)
12–23	25 (15)	23 (25)	23 (40)
24–35	20 (12)	25 (27)	23 (39)
36–47	11 (7)	16 (18)	15 (25)
>48	3 (2)	5 (6)	5 (8)
Total	100 (61)	100 (110)	100% (171)

DISCUSSION

Previous reports have identified heat risks to children in cars, but have primarily described single cases. Our analysis found that heat related deaths to young children in motor vehicles occur each year, primarily during warmer months, and throughout the country. Three quarters of deaths were due to adults leaving children unattended, intentionally and unintentionally. Lack of adult supervision was frequently an issue, including in the one quarter of fatalities occurring to children playing in unlocked vehicles.

Overall, almost twice as many boys died as girls. The Institute of Medicine stated that ''injury death rates were higher for males than for females in each age group except for infancy when the rates were similar. In 1995 for children 1–9 years of age, injury death rates for males were about 1.5 times the rates for females, and the difference increases with age''.[19] Our results show a greater gender disparity for this cause of death: young boys accounted for three quarters of playing cases and three fifths of unattended cases.

The frequency with which children play or are left in motor vehicles is unknown. However, a survey in the United States reported that 10% of parents of young children thought it ''acceptable'' to leave children unattended in vehicles, in contrast to a Japanese survey ranking this behavior second on a list of ''crimes, unethical and immoral acts''.[20 21]

Virtually all cases in our study were identified through searching multiple standard online news sources. The NHTSA special study found 23 deaths in 1998 by searching Nexis; using a broader search strategy, we found 25 in that year meeting our case criteria. No new cases were identified through email lists.

News sources provide information that is not available from traditional public health datasets. We found it helpful to learn the location of the vehicle; circumstances in which the child was entrapped; length of time the child was left; child's name; vehicle description; parents' names, ages, and employment status; ages and presence of other children; and legal outcomes. News accounts could also be used to analyze non-fatal events, although these reports frequently lack identifiers, and health and legal outcomes are not reported if the case is referred to child protective services.

Limitations

This study is a descriptive analysis from which relative risk cannot be calculated because of insufficient information about risk exposure (the number of children left unattended in motor vehicles and the amount of time spent in the

Key points

- Young children frequently play or are left in motor vehicles, and each year several dozen die from hyperthermia as a result.
- News accounts provide rich details of many of the circumstances involved in this under-studied cause of death.
- Almost half of the deaths involved child care providers or parents who meant to bring their children to child care while they worked.
- Changes in routine frequently contributed to insufficient supervision of children as well as to incidents where children were left behind by adults.
- Unlocked vehicles present a significant hazard to young children.

vehicle). Nor can we calculate incidence without population based data.

Despite our best efforts, we do not believe we captured all incidents occurring in the time period covered. We excluded 20 deaths from this study because we could not confirm they were heat related or learn enough details to ensure that they were not duplicates. Only deaths covered in the news, and particularly in news sources available online, were identified. Different accounts of the same death sometimes contained inconsistent information. To address this, we relied on the most recent news accounts as more accurate than reports issued early in the investigations.

We excluded deaths occurring before 1995 because older internet based news archives are more limited in their availability and scope, and are more expensive to access.

Lack of controlled vocabulary in news archives presents search difficulties. We employed multiple search terms to capture as many variants as possible (for example, *child*, *toddler*, *tot*, *baby*, *infant*, *boy*, *girl*). We also searched for ''hypothermia'' deaths using the same strategies as previously described but found only two (non-fatal) cases of child hypothermia in vehicles and a number of instances of reporters, investigators, and judges misnaming hyperthermia deaths.

Prevention

Injury prevention practitioners can work broadly with health professionals and child care providers to increase their knowledge and to set relevant policies to prevent heat related deaths, as well as urge motor vehicle and child safety seat manufacturers to build in warning systems and other design features.

Education

- *Remind parents* to keep cars locked when not in use, to avoid leaving children in cars, and to look in the car first if a toddler is missing. Emphasize that vehicles are inappropriate places for children to play or to nap: keep them locked and remove sleeping children.[22] Parents and caregivers should supervise young children more closely during changes in routine and times of upheaval or family chaos.
- *Educate parents about heat vulnerability* of young children and about the ''greenhouse effect'' that can occur rapidly within vehicles. Provide parents with simple reminding devices that a child is in the back seat (a teddy bear in the front seat, or placing their briefcase in the rear seat with the child).
- *Promote appropriate use of child safety seats*. Child passenger safety advocates should counsel parents that seats are not a safe substitute for adult supervision.

Regulation

- *Establish absentee child care policies* requiring that absences be phoned in, or parents will be contacted. Parents can encourage their providers to make these procedures part of their safety routines even if no regulation exists.
- Stores and shopping centers could institute frequent patrols of their lots and *report incidents to public safety officials*.
- *National and federal agencies should examine the risks* to children confined in vehicles along with other non-traffic events. Motor vehicle trunk entrapment came to national attention in the United States through the efforts of survivor advocates, and fueled by three widely publicized incidents in which 11 children died in one summer.[23 24] NHTSA was mandated to form an expert panel, which recommended vehicle design changes. As a result, a federal motor vehicle safety standard was issued in 2000, requiring interior trunk releases in new vehicles.[25] This simple design change, along with widespread public education about the risks of trunk entrapment, may have already reduced this cause of a small number of deaths.

Engineering

- Auto manufacturers should aggressively *research technology* to reduce the ease with which children gain access to vehicles, or can be inadvertently left behind, especially in child safety seats. The National Aeronautics and Space Administration (NASA) has developed a device to alert drivers when a vehicle is locked from the outside and weight is sensed in the child safety seat.[26] (This initiative resulted from the heat related death of an infant, forgotten in a NASA employee's vehicle.)

Legislation

- *Enact policy change* by passing relevant laws. Three states—California, Illinois, and Kentucky—have recently passed laws to hold adults responsible for leaving children unattended in motor vehicles.[27]

SUMMARY

No national data sources track heat related incidents to children in motor vehicles, keeping this cause of death invisible. However, practitioners do not need to wait for national statistics in order to mount public awareness campaigns and other interventions to reduce these preventable deaths. Drivers should be frequently reminded to keep cars locked when not in use, and to avoid leaving children in vehicles for any length of time. Child care providers should implement more effective absentee policies. Auto manufacturers should provide warning systems as an important safety component of family vehicles. More localities should pass laws to make it illegal to leave children unattended in vehicles.

Authors' affiliations
A Guard, Join Together, Boston University School of Public Health, Boston, Massachusetts, USA
S S Gallagher, Education Development Center, Newton, Massachusetts, USA

Postscript: The authors welcome identification of additional cases. Please email aguard@edc.org or sgallagher@edc.org.

REFERENCES

1 **Roberts KB**, Roberts EC. The automobile and heat stress. *Pediatrics* 1976;**58**:101–4.
2 **Wadlington WB**, Tucker AL Jr, Fly F, *et al*. Heat stroke in infancy. *Am J Dis Child* 1976;**130**:1250–1.
3 **Hassall IB**. Small children left alone in parked cars. *N Z Med J* 1983;**96**:25.
4 **King K**, Negus K, Vance JC. Heat stress in motor vehicles: a problem in infancy. *Pediatrics* 1981;**68**:579–82.
5 **Surpure JS**. Heat-related illness and the automobile. *Ann Emerg Med* 1982;**11**:263–5.
6 **Centers for Disease Control and Prevention**. Heat-related deaths—United States, 1993. *MMWR Morb Mortal Wkly Rep* 1993;**42**:558–60.
7 **Centers for Disease Control and Prevention**. Heat-related illnesses and deaths—Missouri, 1998 and United States, 1979–1996. *MMWR Morb Mortal Wkly Rep* 1999;**48**:469–73.
8 **Gibbs, LI, Lawrence DW, Kohn MA**. Heat exposure in an enclosed automobile. *J La State Med Soc* 1995;**147**:545–6.
9 **Tzunuki-Hayakawa K**, Tochihara Y, Ohnaka T. Thermoregulation during heat exposure of young children compared to their mothers. *Eur J Appl Physiol* 1995;**72**:12–17.
10 **Centers for Disease Control and Prevention**. Injuries and deaths among children left unattended in or around motor vehicles—United States, July 2000–June 2001. *MMWR Morb Mortal Wkly Rep* 2002;**51**:570–2.
11 **National Highway Traffic Safety Administration**. *Data collection study: deaths and injuries resulting from certain non-traffic and non-crash events*. Washington, DC: US Department of Transportation, 2004.
12 **National Highway Traffic Safety Administration**. *Fatality analysis reporting system (FARS) description*. Available at: http://www.nhtsa.dot.gov/people/ncsa/fars.html (accessed 10 April 2001).
13 **Hayden GJ**, Gerberich SG, Maldonado G. Fatal farm injuries: a five-year study utilizing a unique surveillance approach to investigate the concordance of reporting between two data sources. *J Occup Environ Med* 1995;**37**:571–7.
14 **Rainey DY**, Runyan, CW. Newspapers: a source for injury surveillance? *Am J Public Health* 1992;**82**:745–6.
15 **Voight B**, Lapidus G, Zavoski R, *et al*. Injury reporting in Connecticut newspapers. *Inj Prev* 1998;**4**:292–4.
16 **Baullinger J**, Quan L, Bennett E, *et al*. Use of Washington State newspapers for submersion injury surveillance. *Inj Prev* 2001;**7**:339–42.
17 **Nexis**. News Library, Easytrac, Electric Library, New York Times archive, NewsFinder, CARL, RocketNews and Google.
18 ***Child-fatal-L***, hosted by Cornell University, serving child protection and child fatality review team professionals; *Injury-L*, hosted by West Virginia University, serving injury prevention professionals, and *STIPDA-L*, the list of the State and Territorial Injury Prevention Directors Association.
19 **Bonnie RJ**, Fulco CE, Liverman CT. *Reducing the burden of injury: advancing prevention and treatment*. Institute of Medicine, Washington, DC: National Academy Press, 1999:50.
20 **Bruskin Goldring Research**. *Child safety survey conducted for National Safe Kids Campaign*. Washington, DC: Bruskin Goldring Research, 1999.
21 **Hakuhodo Institute of Life and Living**. *Japanese ethical standards of the 1990s*, 1997.Available at: http://www.athill.com/english/English/no3/3_hill5.html (accessed 1 May 2002).
22 **California Unattended Kids** + **Cars Expert Panel**. *Recommendations*. San Francisco: CA, 2001.
23 **McLoughlin E**, Fennell J. The power of survivor advocacy: making car trunks escapable. *Inj Prev* 2000;**6**:167–70.
24 **Centers for Disease Control and Prevention**. Fatal car trunk entrapment involving children—United States, 1987–1998. *MMWR Morb Mortal Wkly Rep* 1998;**47**:1019–22.
25 **National Highway Traffic Safety Administration**. Federal motor vehicle safety standards: interior trunk release final rule. *Federal Register* 2000;**65**:63014–21.
26 **National Aeronautics and Space Administration**. *NASA develops child car-seat safety device*. Press release, 5 February 2002. Hampton, VA: Langley Research Center, 2002.
27 **KidsnCars website**. Available at: http://www.kidsncars.org (accessed 15 August 2002).

LACUNAE

ANEC report on child protective products

''Child protective products'' are products that are intended to prevent children from accessing dangerous sites. A broad range of items fall under this product category including barriers, guards, covers, locks and locking devices, restraints, containers, fixings, and retainers. In 2003, ANEC, the European consumer voice in standardisation, commissioned a study on child protective products as test reports in consumer magazines revealed that many of those products are of poor quality. In particular, the often observed insufficient child protective function raised concerns. Several years ago, the work program of the CEN's technical committee dealing with child care articles (CEN/TC 252) contained the preparation of standards for several products in this field. Unfortunately these work items were later deleted. ANEC's 2003 research project developed proposals for safety requirements and test methods for socket protectors, hob guards, window locking devices, and locking devices for cupboards and drawers. ANEC will use its research report to ask the European Commission for a standardisation mandate for these products. The report is available on ANEC's website: http://www.anec.org/attachments/r&t005-04.pdf.

Research report on children's climbing skills

Children can and will climb on almost anything that attracts them. Falling is therefore one of the major causes of injuries to children. In many standards for products associated with children, for example playground equipment, the ability to climb is a safety issue that needs to be addressed. For ANEC to argue for appropriate requirements in standards, research was required into children's ability to climb a range of products to identify what they can climb and how they use footholds and grip/grasp when climbing these products. In the 2004 research project, a literature review was undertaken, experts interviewed, an examination of different age groups undertaken, and an investigation took place on how children climb and what they climb on. A second part of this study will be carried out in 2005 and will deal with practical tests. The first part of the study can be found on ANEC's website http://www.anec.org/attachments/r&t007-04.pdf.

Changes of address

ANEC, the European consumer voice in standardisation, moved offices in mid-December 2004 to Av de Tervueren 32, Box 27, 1040 Brussels, Belgium. Telephone and fax numbers and email addresses remain unchanged.