

Hazards Associated with Sitting and Carrying Devices for Children Two Years and Younger

Erich K. Batra, MD¹, Jonathan D. Midgett, PhD², and Rachel Y. Moon, MD^{3,4}

Objective To analyze reported mechanisms of injury and characterize risk factors for infants and young children ≤ 2 years of age who died in sitting and carrying devices.

Study design A retrospective review of deaths involving sitting and carrying devices (car seats, bouncers, swings, strollers, and slings) reported to the US Consumer Product Safety Commission between 2004 and 2008.

Results Of the 47 deaths analyzed, 31 occurred in car seats, 5 in slings, 4 each in swings and bouncers, and 3 in strollers. The reported elapsed time between the last time a child was seen by a caregiver and found deceased varied greatly, with a mean of 26 minutes in slings; 32 minutes in strollers; 140 minutes in car seats; 150 minutes in bouncers; and 300 minutes in swings. The cause of death was asphyxiation in all cases except one. Fifty-two percent of deaths in car seats were attributed to strangulation from straps; the others were attributed to positional asphyxia.

Conclusion Infants and children 2 years of age and younger should be properly restrained and not be left unsupervised in sitting and carrying devices. Car seats should not be used as sleeping areas outside of the vehicle, and children should never be in a car seat with unbuckled or partially buckled straps. Infants in slings should have their faces visible and above the edge of the sling, should not have their faces covered by fabric, and their chins should not be compressed into their chests. (*J Pediatr* 2015; ■: ■ - ■).

Sleep-related infant deaths are the most common cause of post-neonatal infant mortality.¹ Sleep-related death is defined as death occurring during sleep or in a sleep environment, including sudden infant death syndrome (SIDS), accidental suffocation and strangulation in bed, and ill-defined deaths. It is recommended that infants sleep in a crib or bassinet, on their backs, and without loose bedding.²

Parents often perceive that their infant does not sleep well in the supine position in a crib, and alternative sleeping environments may be used by parents to calm their child or help the child sleep. Sitting and carrying devices, which include car seats, bouncers (reclined infant seats that allow the occupant who cannot yet sit up unassisted to bounce), swings, strollers, and slings, are purchased by most parents for the primary purpose of transporting infants or confining them. However, many parents find that this may be a convenient and presumably safe place for the infant to be, whether awake or asleep. Indeed, Callahan and Sisler³ found that 94% of infants younger than 5 months spent 30 minutes or longer in seating devices daily, with a mean time of 5.7 hours per day. He also found that 44% of infants spent some time sleeping in the devices.

There is potential for injury when sitting devices are not used for their intended purpose or as originally designed. Closed-head injuries, skull fractures, broken bones, and suffocation have been reported in various sitting and carrying devices.⁴⁻⁷ In addition, others have discussed “SIDS” and “sudden unexplained” deaths in sitting devices.^{8,9} As early as 1994, sitting devices were noted to be potentially hazardous when infants and young children were placed there for sleep.¹⁰ Specific details surrounding the mechanisms of death in these devices are not known. The goal of this report is to describe particular hazard patterns so that guidance might be provided about using these devices. Accordingly, we reviewed cases from the US Consumer Product Safety Commission (CPSC) to elucidate specific mechanisms of injury of sitting and carrying devices for infants and young children and to develop anticipatory guidance that would be useful for counseling parents regarding the use of these products.

Methods

We performed a retrospective review and analysis of deaths of children 2 years and younger that occurred in sitting and carrying devices (car seats, swings, bouncers, strollers, and slings) and that were reported to the CPSC from April

CPR	Cardiopulmonary resuscitation
CPSC	US Consumer Product Safety Commission
INDP	In-Depth Investigation
SIDS	Sudden infant death syndrome

From the ¹Departments of Pediatrics and Family and Community Medicine, Penn State Milton S. Hershey Medical Center, Penn State College of Medicine, Hershey, PA; ²Office of Hazard Identification and Reduction, US Consumer Product Safety Commission, Bethesda, MD; ³Division of General Pediatrics and Community Health, Goldberg Center for Community Pediatric Health, Children's National Medical Center; and ⁴Pediatrics, George Washington University School of Medicine and Health Sciences, Washington, DC

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Table I. Hazards of sitting and carrying devices for children 2 years and younger (gender and age ranges for each device)

Device	No.	Male	Female	Unknown	% of total in study	Mean age at death, mo	Median age at death, mo	Age range
Car seats	31	14	16	1	66	9.7	9	1-24 mo
Slings	5	3	2	0	11	2	1	10 d to 5 mo
Swings	4	3	1	0	9	3.6	2.9	18 d to 8 mo
Bouncers	4	3	1	0	9	2.5	2.5	2-3 mo
Strollers	3	2	1	0	6	5.7	7	2-8 mo
Total	47	25	21	1		7.5	7	

2004 to December 2008. Data were obtained through a Freedom of Information Act request to the CPSC. CPSC staff searched the following CPSC databases: the In-Depth Investigation (INDP) file, the Injury or Potential Injury Incident file, and the Death Certificate file. Reporting to the CPSC is voluntary and can be done by anyone, including consumers, medical examiners, retailers, health care personnel, and emergency personnel. Two of the databases (Injury or Potential Injury Incident and Death Certificate) contain information from death certificates and reports from medical examiners, coroners, emergency personnel, and media.¹¹ In addition, based on reports in these 2 databases, the CPSC conducts INDPs, which include interviews with family members, witnesses, and other local officials about specific cases; the investigation reports are housed in the third database, the INDP. INDPs are assigned by CPSC staff on an as-needed basis depending on resources and the discretion of multidisciplinary teams tasked with reviewing incident information and, as such, do not represent any systematic sampling of the data coming into the agency and cannot be used for statistical purposes. The cause of death determination was abstracted from the reports.

Results

We analyzed records for 47 deaths associated with sitting and carrying devices for infants and children 2 years and younger. The records received included 22 CPSC INDPs. Two-thirds (31, 66%) of the cases occurred in car seats. The remainder of the cases occurred in slings (5, 11%), swings (4, 9%), bouncers (4, 9%), and strollers (3, 6%) (Table I).

The “elapsed time” is defined as the time between when the infant was discovered and when last seen alive (when available from the records) and is summarized in Table II. The

Table II. Hazards of sitting and carrying devices for children 2 years and younger (mean and median elapsed time)

Device	No. cases with elapsed time	Mean elapsed time	Median elapsed time	Range
Car seats	10	2.3 h	55 min	4 min-11 h
Slings	4	26 min	18 min	10-60 min
Swings	4	5 h	5 h	1-9 h
Bouncers	3	2.5 h	2 h	1.5-4 h
Strollers	3	32 min	30 min	5-60 min

elapsed time is recorded from the reports, as described by the investigators or witnesses. The elapsed time for all devices ranged from 4 minutes to 11 hours, with both of these extremes associated with car seats. The case that was 4 minutes was for a 22-month-old girl whose mother had left the room; it was unclear whether a 3-year-old sibling partially unbuckled the car seat restraint during that time.

Twenty-seven cases had information about why the child was placed in a device. Of these, 17 documented that the child was placed in the device with the intention of having the child fall asleep, 5 cases involved children being placed in car seats to travel, 4 stated the reason was to contain the child, and in one case a child died while playing with other children after she crawled into the car seat that subsequently flipped over.

With regards to deaths that occurred in the slings, none were reported to have occurred during breastfeeding. In one case, the infant was nursing and then the mother noticed that he had stopped suckling and apparently had fallen asleep. Ten minutes later she found him lifeless.

The cause of death was asphyxiation (positional asphyxia or strangulation) for 46 of the 47 cases. All deaths in slings, bouncers, and strollers were attributed to positional asphyxia. Fifty-two percent of deaths associated with car seats were attributed to strangulation from straps, and the other 48% were attributed to positional asphyxia. Three of the 4 deaths in swings were attributed to positional asphyxia, and 1 had an unclear cause of death. In that case, premature twins were placed in a swing, which was found tipped over, with the deceased twin under the other twin.

The location of death was listed as a home for 100% of the deaths associated with bouncers and swings. Two of the 3 stroller deaths occurred in a home, and 1 occurred at a workplace. Of the sling deaths, 2 occurred in a home, 1 in a church, and 1 in another public setting, with one case not listing where the death occurred. Of the 31 deaths associated with car seats, 18 cases documented location, with 16 of those outside of the car (13 in a home, 3 in a daycare) and 2 in the car.

Four of the devices (car seats, swings, bouncers, and strollers) in the study have restraints/straps. Of the 42 cases involving these devices, 15 listed whether the straps were present and whether they were being used properly at the time of death. Ten car seat cases and three stroller cases described improper use of the restraints/straps. One swing and one bouncer case noted that the straps were used properly. Seven devices were found in a position that is different from their

expected use. Five car seats were found on top of the child; 2 of these events occurred on beds. One swing folded in on itself, and 1 swing that had 2 twins in it tipped over.

The illustrative cases to follow describe situations that may have contributed to the mechanism of death.

Car Seats

Case 1. An 11-month-old boy was placed with a bottle in a car seat for a nap at a home day care center. He was covered with a fleece blanket. The chest buckles were secured, but the lower buckles were unsecured. One hour and 20 minutes later, the child care provider went into the room to check on the child. She saw that he had slipped down in his car seat, such that at least one strap was up against his neck, his color was pale, and he was gasping for breath. EMS was called and the victim was transported to a hospital, where he was declared dead.

Case 2. An 8-month-old girl was placed in a car seat with 3 blankets and 1 infant pillow. Safety restraints were not used. The car seat was placed in a crib. The infant's neck became caught between the edge of the car seat and the attached folded sunshade. She was transported to a hospital, where she died 2 days later.

Slings

Case 3. A mother was attending a breastfeeding class with her 26-day-old son. She was wearing a cloth baby sling that was placed like a sash across her chest. The child was breastfeeding inside the sling. The child stopped nursing and was believed to have fallen asleep. Approximately 10 minutes later the mother noticed that her son was unresponsive. Cardiopulmonary resuscitation (CPR) was initiated. The child was transported to a hospital and pronounced dead.

Swings

Case 4. After being fed, an 18-day-old boy was placed to sleep with 2 blankets in a portable infant swing. When the victim's mother awoke an hour later, she discovered that he was not breathing. CPR was initiated, but he was pronounced dead at a hospital. It is unknown whether restraint straps were used.

Bouncers

Case 5. A 3-month-old boy was placed for sleep on his back in a bouncer. The father buckled the infant into the seat with the restraint belt and placed a blanket on him up to his waist. Ninety minutes later, the father found the victim face down and unresponsive, with his neck over the top of the bouncer. 911 was called and CPR started; the baby was pronounced dead at the scene. The detective related that the victim had apparently rolled over and pushed up to the top of the bouncer by pushing on the blankets.

Strollers

Case 6. An 8-month-old girl was sleeping unattended in a stroller at the mother's workplace. The restraint belt was

not fastened. The mother returned to the room after 5 minutes and found her partially hanging out of the stroller, her head wedged between the lower edge of the tray and the front edge of the seat. She was unconscious and not breathing, so CPR was initiated. She was resuscitated but was in a vegetative state, and life support was withdrawn 2 days later.

Discussion

The 2011 American Academy of Pediatrics Task Force on SIDS's policy statement recommends that infants sleep in a crib, bassinet, or portable play yard with a firm mattress. Specifically, sitting devices such as car safety seats, strollers, swings, infant car seats, and infant slings are not recommended for sleeping because of the potential for upper airway obstruction and oxygen desaturation.² Sitting and carrying devices are advertised and used for many reasons, including transporting infants in a car, placing an infant in a safe place when not being held, calming a fussy/colicky infant, and facilitating breastfeeding. Many parents also use these devices as places for their infant or young toddler to sleep without realizing that there are potential dangers involved with these devices.⁴⁻⁹ We describe details of 47 deaths occurring in sitting and carrying devices to illustrate potential mechanisms of injury of these devices, often when used as sleep environments.

It is possible that most, if not all, of these deaths might have been prevented had the device been used properly and/or had there been adequate supervision. Although restraints (car seats, swings, bouncers, and strollers) and design (all devices) may keep infants and young children contained in a general sense, there is both a need for proper restraints and appropriate supervision that has to be considered when these devices are used as currently designed. Manufacturers can consider future designs that make suffocation or strangulation less likely when supervision is not optimal.

Although the peak age for both sleep related deaths and SIDS is at 4-6 months, we found that injury by asphyxiation extended beyond this age range, with deaths in car seats occurring up to 2 years. Deaths in the other devices occurred in infants up to 8 months of age. The age range at death for particular devices may be a reflection of the age range for typical use of these devices. For instance, it is not surprising that deaths in car seats often occurred in older infants and toddlers because car seats with a harness are recommended for children up to at least four years of age.¹²

The elapsed time provides an interesting glimpse into not only how quickly infants and young toddlers can succumb to vulnerable situations, but also into the length of time children are left in these devices without close supervision. With median elapsed times of 18 and 30 minutes for slings and strollers, respectively, and up to 9 hours for swings, it should be recognized that there may not be a safe amount of time that infants can be left unsupervised in these devices.

There were 2 main mechanisms for death in car seats, with 52% of the victims dying from strangulation by the car seat restraint straps, and 48% dying from positional asphyxia. In addition, 89% of the car seat deaths with a documented location occurred outside of the car. Inferring from our and others' data, an infant in a properly positioned car seat, in a car, with the straps properly attached is at little risk of suffocation or strangulation. Bamber et al¹³ found "no cases of previously healthy infants dying unexpectedly in a car seat when it was being used appropriately." The problem occurs when car seats are used as sleeping devices in the home. They are not stable outside of a car and can topple over when not secured (ie, by a seatbelt), which can put a restrained or partially restrained infant in a compromising position, as illustrated in 2 of our cases.

Juvenile product standards typically are developed by ASTM International (formerly the American Society for Testing and Materials) using a consensus-based approach with participants from industry, consumer groups, and government. The industry standard for hand-held infant carriers (ASTM F2050) requires a warning on the car seat to address this hazard.¹⁴ The warning states: "NEVER leave child unattended," and "Suffocation Hazard: Infant carrier can roll over on soft surfaces and suffocate child. NEVER place carrier on beds, sofas, or other soft surfaces."

Caregivers may be tempted, for the infant's comfort, to unfasten the restraints on car seats once the child is out of the car, assuming that the straps are no longer needed. Partially buckled children present a very dangerous situation because the infant can move and become entangled on the loose straps. The ASTM standard also has a warning with an illustration stating that this has occurred: "Warning: Children have STRANGLED in loose or partially buckled harness straps. Fully restrain the child even when carrier is used outside the vehicle." We surmise that many parents feel a car seat is a "safe" environment because it provides clear protection in the event of a car crash. The unfortunate irony is that the mechanism that makes an infant so safe in a car, ie, buckled straps, may be extremely hazardous when used incorrectly.

In slings, swings, bouncers, and strollers, all of the deaths were from positional asphyxia, except one swing death that had an unclear cause of death. The latter 3 devices often have straps included, but these straps are not as substantial as the straps used in a car seat. The straps in swings, bouncers, and strollers are often thinner in width and designed with a waist and a crotch restraint, ie, a 3-point harness. Although a 3-point harness might provide some positioning help, if the harness is not tightened it will not prevent infants from getting themselves into positions that compromise their airways. In addition, if there is soft bedding (blankets, pillows) in the device, the infant could asphyxiate by moving in the device so that the airway is compromised by the soft bedding. Often, the case reports do not contain enough information to ascertain how tightly the restraints were fastened. The most recent version of the standard covering swings (ASTM F2088) requires shoulder straps if the seat back is greater

than 50 degrees from horizontal.¹⁵ If the shoulder straps are used by caregivers according to the manufacturer's instructions, they may prevent many of the problems associated with improper adjustments of 3-point harnesses. Because such restraint systems may be ignored by consumers or used incorrectly, a passive restraint system might prove more effective.

Slings present a particular challenge because, unless there is constant supervision of neck angle and airway patency, it is very easy for an infant's airway to be compromised in a short period of time. Slings with designs that do not easily allow the caregiver to view the infant's face are particularly worrisome because the infant's face may be occluded by the caregiver's body. Caregivers who own slings that do not keep the baby "visible and kissable" at all times should not use those products. CPSC recommendations should be followed.¹⁶

The limitations of this study are largely due to the data source. CPSC investigations are conducted in response to specific incidents involving a product, which immediately creates bias. In addition, this review encompassed a variety of designs and models for each of these products. Furthermore, because reporting is voluntary and ongoing, this review should not be considered a comprehensive, but rather a minimum accounting of deaths associated with sitting devices; nor is it intended to represent a statistical sample of such deaths. Because there are no data about how many infants are placed in these devices, and because this review represents an unknown proportion of these deaths, this study does not make any attempt to calculate rates of death or risk due to the aforementioned factors. In addition, SIDS deaths were not included in this dataset. Therefore, there may be additional risk factors for death that were not evident in this review. Finally, reports are anecdotal, there is much variability in the type and amount of information available for each case, and these deaths are unwitnessed, which makes identifying the true cause of death difficult. CPSC strongly discourages the drawing of any inferences based on the year-to-year increase or decrease shown in the reported data.

Infants and young children should not be left unsupervised (awake or asleep) in a sitting or carrying device. Infants and young children of any age should never be in a car seat with unbuckled or partially buckled straps. Car seats with a child inside should never be placed on a soft or unstable surface because the car seat can tip over or fall. Infants in bouncers, strollers, and swings may be able to maneuver into positions that could compromise their airway; straps on these devices may not prevent infants from getting into hazardous situations. Parents should ensure that infants cannot twist their heads into soft bedding or slump forward in a seat; and parents should always use the restraints provided according to manufacturer's instructions. Slings are particularly hazardous because of their design and the ease with which an infant's airway can be collapsed. If used, the baby's face should be visible, not covered by any fabric, the chin should not be compressed into the chest, and the face should be above

the edge of the sling. More than one infant should not be placed together in a swing meant for one infant because there is the potential for overlay or entrapment to occur, and the swing may become unstable and tip over. ■

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Reprint requests: Erich K. Batra, MD, Penn State Milton S. Hershey Medical Center, Penn State College of Medicine, Department of Family and Community Medicine, 500 University Drive-H154, Hershey, PA 17033 E-mail: ebatra@hmc.psu.edu

References

- Centers for Disease Control and Prevention, National Center for Health Statistics. Compressed Mortality File 1999–2010 on CDC WONDER Online Database, released January 2013. Data are compiled from Compressed Mortality File 1999-2010 Series 20 No. 2P, <http://wonder.cdc.gov/cmfi-icd10.html>; 2013. Accessed April 23, 2014.
- Moon RY, American Academy of Pediatrics, Task Force on Sudden Infant Death Syndrome. SIDS and other sleep-related infant deaths: expansion of recommendations for a safe infant sleeping environment. *Pediatrics* 2011;128:1030-9.
- Callahan CW, Sisler C. Use of seating devices in infants too young to sit. *Arch Pediatr Adolesc Med* 1997;151:233-5.
- Pollack-Nelson C. Fall and suffocation injuries associated with in-home use of car seats and baby carriers. *Pediatr Emerg Care* 2000;16:77-9.
- Parikh SN, Wilson L. Hazardous use of car seats outside the car in the United States, 2003-2007. *Pediatrics* 2010;126:352-7.
- Graham CJ, Kittredge D, Stuemky JH. Injuries associated with child safety seat misuse. *Pediatr Emerg Care* 1992;8:351-3.
- Wickham T, Abrahamson E. Head injuries in infants: the risks of bouncy chairs and car seats. *Arch Dis Child* 2002;86:168-9.
- Cote A, Bairam A, Deschenes M, Hatazkis G. Sudden infant deaths in sitting devices. *Arch Dis Child* 2008;93:384-9.
- Freyne B, Hamilton K, McGarvey C, Shannon B, Matthews TG, Nicholson AJ. Sudden unexpected death study underlines risks of infants sleeping in sitting devices. *Acta Paediatr* 2014;103:e130-2.
- Byard RW, Beal S, Bourne AJ. Potentially dangerous sleeping environments and accidental asphyxia in infancy and early childhood. *Arch Dis Child* 1994;71:497-500.
- US Consumer Product Safety Commission. A description of the Injury or Potential Injury Incident Database (IPII). Bethesda (MD): US Consumer Product Safety Commission; 1992.
- Durbin DR. American Academy of Pediatrics, Committee on Injury, Violence, and Poison Prevention. *Pediatrics* 2011;127:788-93.
- Bamber AR, Pryce J, Ashworth MT, Sebire NJ. Sudden unexpected infant deaths associated with car seats. *Foresnsic Sci Med Pathol* 2014;10:187-92.
- ASTM Standard F2050-13a. Standard Consumer Safety Specification for Hand-Held Infant Carriers. West Conshohocken, PA: ASTM International; 2013 <http://dx.doi.org/10.1520/F2050>, <http://www.astm.org/Standards/F2050.htm>. Accessed March 26, 2015.
- ASTM Standard F2088-13. Standard Consumer Safety Specification for Infant Swings. West Conshohocken, PA: ASTM International; 2013 <http://dx.doi.org/10.1520/F2088-13>, <http://www.astm.org/Standards/F2088.htm>. Accessed March 26, 2015.
- US Consumer Product Safety Commission, <http://www.cpsc.gov/en/Newsroom/News-Releases/2010/Infant-Deaths-Prompt-CPSC-Warning-About-Sling-Carriers-for-Babies/>. Accessed February 23, 2014.