

Original Article

Infant injuries from child restraint safety seat misuse at British Columbia Children's Hospital

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Abstract *Background:* Child restraint safety seats (CRS) are used to prevent injuries or deaths among child passengers involved in a motor vehicle crash. When used outside of a motor vehicle, CRS use could potentially place an infant at risk of injury. The objective of the current study was to describe the proportion of CRS misuse injuries among infants <12 months old and associated factors presenting to the British Columbia (BC) Children's Hospital Emergency Department over 5 years (1997–2002).

Methods: The Canadian Hospital Injury Reporting and Prevention Program (CHIRPP) was the source for the emergency department injury surveillance data used in the present study. BC Children's Hospital is the participating CHIRPP site in British Columbia. A search of individual level patient records was conducted to capture all injuries from CRS misuse taking place during the study period using a predetermined code for 'child car seat-related injuries'. A retrospective analysis of 87 infants <12 months old, who presented at BC Children's Hospital for CRS-related injuries between January 1997 and December 2002 was performed in order to describe the epidemiologic and background factors related to injury occurrence.

Results: Infants aged 0–4 months accounted for approximately 59.7% of cases (52/87). Among all infants, falls were a common mechanism of injury resulting from CRS misuse (98.8%, 86/87). Falls from elevated surfaces (e.g. chairs, tables, counters) were also common among infants presenting to the emergency departments and accounted for 43% of all falls (37/86).

Conclusions: Injury prevention efforts should be focused on reducing CRS outside the motor vehicle setting and preventing placement of the CRS at an elevated surface. Educating caregivers on the dangers of falls resulting from CRS misuse in a variety of care settings is also recommended.

Key words child restraint use, falls, infants.

Unintentional childhood injuries are a leading cause of death and a significant contributor to morbidity and long-term disability in most industrialized countries.^{1–3} Injuries are often preventable yet remain the most common cause of death in children aged 1–19 in North America. Pediatric injuries pose a burden to societies in terms of years of potential life lost, disability, and health-care costs.⁴

To prevent injuries among children involved in motor vehicle crashes, the American Academy of Pediatrics and the National Highway Traffic Safety Administration recommend that appropriate child restraints are used in a motor vehicle.^{5,6} When correctly installed and used in motor vehicles, child restraint safety seats (CRS) have demonstrated effectiveness in reducing severe and life-threatening injuries by approximately 71%.^{7–9} The aforementioned injury reductions are applicable only when CRS are

used for their intended purposes. A small body of research has found that CRS misuse may be a potential source of injury among infants.^{10–15} CRS misuse refers to CRS use outside a motor vehicle.¹² Ongoing observation of infant head injuries on computed tomography (CT) is now being advocated and a representative CRS fall-related case, seen at British Columbia (BC) Children Hospital, is depicted in Figures 1,2. This child, aged 4 months, was improperly restrained in a CRS while in the home. The CRS fell off a low piece of furniture, approximately 3 feet off the ground, and the child's head struck the tiled floor. Figure 1 demonstrates the clinically apparent depressed skull fracture, and Figure 2 shows the fracture on axial CT. The child had the fracture elevated via a small craniotomy.

To date, few investigations on CRS misuse (as defined in the present study) have been conducted.^{13,14} A nationally representative US study by Pollack-Nelson found that 396 infants aged 0–6 months suffered from injuries from CRS misuse (i.e. falls from CRS placement on an elevated surface) and represented one-third of all fall-related injuries among infants during the study year.¹³ A UK study by Wickham and Abrahamson demonstrated that injuries from CRS misuse were present in six cases.¹⁴

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Received 28 June 2006; revised 1 August 2007; accepted 19 October 2007.



Fig. 1 Lateral photograph of the head, depicting a depressed parietal skull fracture.

To add to these findings, the present study will assess injuries from CRS misuse from the BC Children's Hospital Emergency Department in Vancouver, British Columbia, Canada, an area that has not been previously studied for CRS misuse injuries. The objective of the present study was to describe the proportions of injuries resulting from CRS misuse and associated factors among infants <12 months old presenting to the BC Children's Hospital Emergency Department over 5 years (1997–2002).

Methods

The Canadian Hospital Injury Reporting and Prevention Program (CHIRPP) was the source for the emergency department injury surveillance data used in the present study. When an injured child is brought to the emergency room of a participating hospital, the accompanying adult is asked to complete a 1-page questionnaire

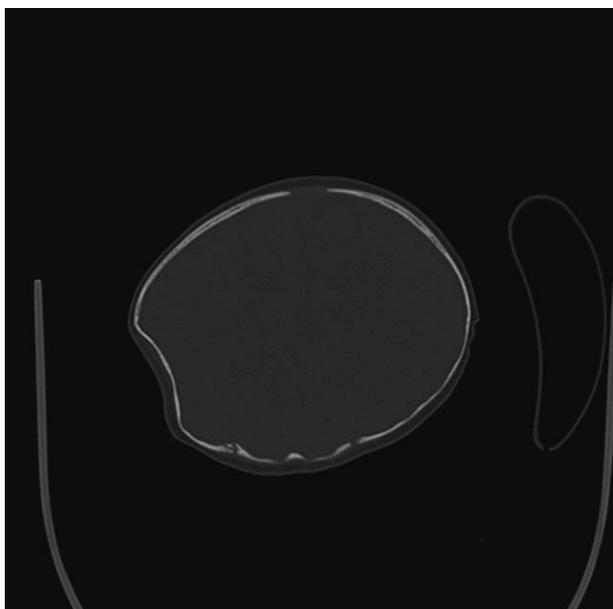


Fig. 2 Axial computed tomography scan, demonstrating a depressed parietal skull fracture.

about the injury incident. Information captured by CHIRPP questionnaires include date of birth, sex, language spoken at home, postal code, injury type and anatomical site, mechanism of injury, date, day of the week and time of the injury, safety devices and vehicle seating position. Three free-text variables describe how the injury happened, location, name of location or address, and details about any involved products such as brand name or model number. The attending physician completes the other side of the questionnaire providing physical examination details on the nature of the injury, body part injured and treatment received. Where data are found to be incomplete, a research nurse conducts a chart review to collect missing information.

For this study, questionnaires were filled out for index episodes of injuries only, any other emergency department visits related to the injury were not recorded as independent visits. Participation in CHIRPP by patients is voluntary.

The CHIRPP records from the BC Children's Hospital Emergency Department were reviewed from 1997 January to December 2002. All CRS-related injuries are coded using a predetermined code. A search of individual level patient records was conducted to capture all injuries from CRS misuse taking place during the study period using a predetermined code for baby and child car seat-related injuries. No age restriction was specified in the search. The following search strategy was used: (child OR infant) AND (baby capsule OR child restraint OR safety seat OR baby carrier OR safety device or seat belt or motor vehicle accident OR falls). The combination of search terms yielded 136 records. Records were then scanned and eliminated if the injury was not directly related to infants and CRS. Based on screening of the records 95 cases were selected for final review.

This study was approved by the University of British Columbia Behavioral Research Ethics Board and Children's and Women Health Centre of British Columbia Research Review Committee.

Results

A total of 95 cases involved injuries from CRS use (misuse and correct use) among infants <12 months from 1997 to 2002. Injuries from CRS use accounted for 4.2% of all injury cases among infants <12 months presented at the BC Children's Hospital Emergency Department (95/2264) during the 5 year study period. Of the 95 cases of injury from CRS use, 87 were the result of CRS misuse (90.9%) and eight were the result of CRS use in motor vehicles for their intended purpose (9.1%).

The mean age for infants experiencing injuries from CRS misuse was 3.10 ± 2.8 months. Injuries from CRS misuse were similarly distributed by sex (boys, 50.6%; females, 49.4%; Table 1). Infants aged 1–4 months were disproportionately represented in the database, accounting for 59.7% of cases (52/87).

Falls accounted for 98.9% of all CRS misuse injuries (86/87). The circumstances commonly surrounding fall in the majority of case were infant fell from a counter or table (24.4%; 21/86) or while being carried (23.3%, 20/86; Table 2).

Narratives accompanying the injury data indicated that three patterns of injury associated with CRS misuse are injuries resulting from (i) falls from an elevated surface; (ii) falls while being carried; and (iii) overturn on floors (Table 3).

Table 1 Infants injured by CRS misuse

Age (months)	Male (%) (n = 44)	Female (%) (n = 43)	Total (n = 87)
0	4 (9.1)	1 (2.3)	5
1	5 (11.4)	5 (11.6)	10
2	10 (22.7)	9 (20.9)	19
3	3 (6.8)	7 (16.3)	10
4	5 (11.4)	8 (18.6)	13
5	3 (6.8)	5 (11.6)	8
6	3 (6.8)	3 (7.0)	6
7	5 (11.4)	1 (2.3)	6
8	3 (6.8)	0 (0.0)	3
9	0 (0.0)	1 (2.3)	1
10	2 (4.5)	1 (2.3)	3
11	1 (2.3)	2 (4.7)	3
12	0 (0.0)	0 (0.0)	0

CRS, child restraint safety seat.

The majority of injuries from CRS misuse occurred in the infant's home (62.1%; 54/87), and resulted in superficial head injuries (64.4%; 56/87; Tables 4, 5).

Discussion

The key findings were that (i) infants aged 1–4 months were disproportionately injured; (ii) head injuries were common; and (iii) that most injuries were the result of falls. The present results support previous literature suggesting that CRS misuse may expose children to falls and head injuries.^{13,14} Head injuries from CRS misuse are of particular concern because infant skulls are malleable and susceptible to fracture and intracranial injury.¹⁵

Another factor explaining injuries from CRS misuse could be parental inexperience. Frequently parents lack the knowledge of effective safety measures to prevent injuries to children, and consequently misuse protective safety devices.^{16,17} Caregivers could benefit from education on proper CRS use by messages placed in a variety of accessible settings. Potential settings include primary care offices, community-based organizations, child care settings, emergency departments, maternity wards and commercial outlets and point of sale locations. Primary care could increase their involvement in education efforts as per the American Academy of Pediatrics, who recognize that injury prevention education for caregivers should be a priority for counseling during routine health maintenance visits for young children,^{5,18,19} and particu-

Table 2 Falls resulting in injury from CRS misuse in infants

Characteristics of falls	CRS misuse falls (%) (n = 87)
Fell while being carried	20 (23.3)
fell from counter or table	
Fell from a chair	21 (24.4)
Fell while on the floor	16 (18.6)
Fell from a stroller	12 (14.0)
Fell off a shopping cart	5 (5.8)
Other	4 (4.7)
Unspecified	4 (4.7)

CRS, child restraint safety seat.

Table 3 Narrative data circumstances surrounding CRS misuse injury (n = 17)

Circumstances surrounding injury	No. responses (n = 17)
Fall from an elevated surface	11
Fall while being carried	3
Tipped on non-elevated surface	2
Non-fall related	1

CRS, child restraint safety seat.

larly that caregivers of young children should be advised about prevention of injuries sustained in the home.^{20–22}

The CRS manufacturers should be advised to expand their instructions to include advice on CRS misuse. CRS manuals would benefit by having the following messages: (i) never place CRS on an elevated surface; and (ii) do not use a CRS outside of the motor vehicle setting. Warnings in word form should be augmented with pictorial representations that articulate the main messages.¹⁴ Pictorial diagrams improve the usability and appear to improve label compliance, especially when a label is positioned in an appropriate location.²³ In addition to changes to instruction manuals and labels, a previous study suggested that there is a need for innovation in the design of CRS, so that they are more functional and stable.¹⁴ To increase stability, CRS design features could be improved to reduce the risk to children, and to allow for multi-purpose usage both inside and outside a motor vehicle.

From a primary prevention perspective, education materials could target post-partum parents to prevent CRS misuse injuries. From a secondary prevention perspective, emergency department nurses or physicians could reinforce CRS misuse warning messages among caregivers who visit emergency departments with an injured infant and in prenatal and postnatal care. A recent review by Gittelman and Durbin suggested that an emergency department visit for an injury represents a 'teachable moment' for the patient and their family, which may make the injured more receptive to educational information.²⁴ A review of injury prevention counseling in primary care settings suggested a consistent positive effect of such counseling on use of car seats and seat belts.²⁵ It also appears that such counseling by pediatricians

Table 4 Place of occurrence of CRS misuse-related injuries

Place where injury occurred	No. CRS misuse (%) injuries (n = 87)
Airport	1 (1.1)
Restaurant	2 (2.3)
Hospital	1 (1.1)
Own home	54 (62.1)
Other person's home	5 (5.8)
Public park	1 (1.1)
Shopping center	7 (8.1)
Industrial area	2 (2.4)
Unspecified place	13 (14.9)
Missing information	1 (1.1)

CRS, child restraint safety seat.

Table 5 Type of injury sustained by infants from CRS misuse

Type of injury	CRS misuse injuries (%) (n = 87)
Head injury	56 (64.4)
Head fracture	3 (3.4)
Intracranial head injury	1 (1.1)
Superficial head injury	1 (1.1)
Upper arm fracture	1 (1.1)
Clavicle fracture	1 (1.1)
Open wound in face	1 (1.1)
Internal mouth open wound	2 (2.3)
Superficial face injuries	8 (9.2)
Superficial lower leg injury	1 (1.1)
No injury	12 (13.8)

CRS, child restraint safety seat.

is cost beneficial.²⁵ Child health-care providers should increase efforts to provide injury prevention counseling.

Limitations

A study limitation is that the data were subject to biases that are inherent in the use of self-report data. It is possible that caregivers may be reluctant to disclose all the details surrounding the injury incident, especially if the caregiver fears that their parenting skills will be under scrutiny.

It is also possible that the figures for CRS misuse injuries in the motor vehicle collisions are an underestimate. The study data indicated that the ratio of CRS misuse injuries to CRS use injuries is approximately 10:1. These trends in the data may be based on the severity of injuries sustained in motor vehicle collisions by infants, leading to bypassing of emergency department surveillance for hospitalization. In addition, children who die from motor vehicle collisions due to lack of CRS are also not captured in the database. This theory is supported by data suggesting that relative to other injuries among infant populations, CRS misuse injuries account for a small proportion of non-severe injuries because the majority of emergency department visits were categorized as required advice only, with a small number requiring treatment and follow up. Other non-severe injuries could be captured through community-based research on factors associated with CRS misuse.

CRS misuse injuries reported to the CHIRPP database may also be underestimated due to lack of participation in the CHIRPP program. Currently, CHIRPP participation in the BC Children's Hospital is at approximately 80% (M. Nolan, pers. comm., 2006), but participation rates for the study period 1997–2002 are unavailable.

Conclusions

The present study examined CRS injuries presenting to the BC Children's Hospital Emergency Department in Vancouver, British Columbia, Canada. Preventative strategies should focus on developing knowledge and understanding among caregivers of the risks associated with CRS misuse. Work with designers and manufacturers to produce detailed CRS misuse label warnings may be helpful in preventing injuries. Additional studies are warranted, especially at the population level, to determine the extent of CRS misuse injuries in other contexts.

Acknowledgment

We gratefully acknowledge CHIRPP for generous provision of the data.

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