MISUSE OF RESTRAINTS BY CHILD OCCUPANTS

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Abstract

The objective of this research is to characterise the type and frequency of restraint misuse by child occupants, and the implications for restraint effectiveness. This paper presents preliminary findings from three areas - a field study of restraint misuse, real-world injury cases, and crash simulations in the laboratory. Results from these studies demonstrate that misuse is widespread in all restraint types, and includes errors in installation of child restraints and incorrect use of the restraint by the occupant. Injury data shows that incorrect use of the restraint by the occupant (e.g. excessive slack in harnesses, placing sash belt under the arm or behind the back) can be associated with catastrophic injuries. Laboratory simulations demonstrate the injury mechanisms are the result of excessive occupant motion allowed by the restraint. This research demonstrates that to get the full protective benefit from restraints, it is not only important that children use the most appropriate restraint for their size, but that the restraint is used correctly. Failure to educate parents on the correct use of restraints could potentially negate the benefits of appropriate restraint use laws and guidelines.

Introduction

It has been well established that restraining children in cars prevents death and injury (1-12), however, the way a child uses a restraint will influence the efficacy of that restraint in a crash (3, 12-16). Restraints must be used exactly as intended to achieve full protection potential. Field studies both in Australia and overseas have shown that children seriously injured in crashes while using a restraint are commonly using that restraint incorrectly (3,5, 11, 14-19).

Incorrect use of restraint systems by children is generally termed 'restraint misuse', and is known to be a common problem. However, exactly how widespread incorrect use is in the general population is difficult to determine. There have been few comprehensive studies of this problem. Most published work relates to incorrect use identified among children involved in crashes (3, 13-16, 20). Studies that have targeted non-crash involved samples have been limited to non random, convenience sampling methods (20-22). All population-based restraint observation studies conducted to date have involved roadside observation of restraint use. This type of methodology involves observation of occupants in their vehicles as they travel in traffic, and therefore does not allow adequate detail related to correctness of restraint use to be observed. In North America, non population based observational surveys have shown that about 80% of child restraints were not being used as intended (20). An Australian study of child restraint installations conducted in a convenience sample in Australia (21-22) observed that there were problems with how the restraint system was fitted in the vehicle in 39% of cases. Data related to how children were using their restraints was collected from only a small sample, but suggested that about 30% of forward facing restraints may be being used with too much slack in the harness. None of this data, however, was collected using population-referenced samples, or with the current range of Australian restraints. Nor did this data include inspection of the restraint and observation of the child in the restraint. Available data relating to the types of misuse encountered in Australia does therefore not provide a comprehensive overview of the extent and nature of the misuse problem. There is a need to establish the rate of misuse in Australia, what types of misuse occur, and the reduction in protection associated with each type of misuse.

Different types of misuse can have different effects on child restraint performance. While there have been a number of laboratory studies demonstrating that some forms of misuse have relatively minor impacts, and others have significant implications on the protection provided in a crash (20), there has been no such study conducted previously in Australia. Nor have many studies investigated both installation and use problems, and misuse of different types of restraints. Understanding the impact of different forms of misuse is important in setting priorities for the development of countermeasures to this problem.

Following observations made in our field studies of children in crashes that demonstrated the potential catastrophic nature of some forms of misuse (19), the child injury research group at the Prince of Wales Medical Research Institute began a series of projects looking at both the extent and potential impact of incorrect use in Australia. This includes a population based inspection study examining the extent and types of incorrect use occurring across NSW, re-examination of cases from our field study and extensive laboratory work. This paper presents preliminary results from these studies, illustrating the extensive nature of the misuse problem and the impact this is having on the level of protection provided to restrained children.

Methods

The work being presented is drawn from three different areas of study. This includes a targeted population based field study of misuse; re-examination of real world crash field data and specific cases where misuse featured in the mechanism of injury; and a number of laboratory test programs exploring the impact of misuse on the level of protection provided. A brief description of the methods used in each of these areas is provided.

Field Misuse Study

The study aims to provide population-referenced data on the extent and form of restraint misuse among children aged 0-12 years. A multistage stratified cluster sampling plan is being used to achieve this. This plan allows for the observation and restraint inspection of 600 children randomly selected from the following institutions: - baby/child health clinics; pre schools/ day care centres; and primary schools.

Four strata have been constructed from local government areas (LGAs) using the Australian Classification of Local Governments (ACLG) which is based on geographical location, socioeconomic characteristics, and accessibility to services. The strata being used are Urban – Capital City/Metropolitan developed (Metropolitan); Urban – Regional Town/City (Regional); Urban – Fringe (Fringe); and, Rural (Rural).

Individual LGAs have then been randomly selected from each stratum. The number of LGAs selected in each stratum is proportional to population size. The population within the combined ‘Metropolitan’ strata accounts for approximately 40% of the population, therefore 4 LGAs will be drawn from the metropolitan strata. Population within ‘regional’ areas accounts for almost 30% of the population, therefore 3 LGAs will be drawn; likewise 2 LGAs will be selected from ‘fringe’ regions and 1 from the rural regions.

A random list for each type of institution in each cluster was then drawn, and institutions within each cluster were inspected for suitability as a data collection site. An alternative list was also drawn to allow substitution for any institution that was unsuitable or does not want to participate. Based on sufficient size of intra age range variations, the aim is to collect data for 15 children aged 0-2; 15 children aged 3-5; 15 children aged 6-8; and 15 children aged 9-12 from each LGA.

During data collection, researchers attend the site over a one to two hour time period corresponding with drop off times at preschools and primary schools, and morning and afternoon sessions at early childhood health clinics. Potential participants are approached as they pull into a parking spot outside the institution, and initial observations with the child in situ are made. The driver of the vehicle is then invited to participate. All refusals are recorded. A structured interview is conducted with those agreeing to participate and the height and weight of the child is measured. A detailed examination of the restraint installation is conducted while the interview is taking place. The study selects only one child per vehicle. Among vehicles carrying more than one child, the participating child is randomly selected by including the child who had the most recent birthday.

All data collectors are knowledgeable in the area of child occupant protection, and inspections are carried out by researchers highly experienced in child restraint design and installation. Approval for the conduct of this study was granted by the UNSW Human Research Ethics Committee.

This study is ongoing. To date data collection for all children aged 3-5 in metropolitan and fringe areas is complete, and almost half the data for children aged 0-2 in these areas is complete.

<u>Real World Crash Study</u>

Injury outcome and the implications of restraint misuse in restrained children was studied using data collected through a retrospective review of all children involved in crashes. This review included all children aged 2-8 years who presented to the emergency department of the Children's Hospital, Westmead Sydney following involvement in a motor vehicle crash as an occupant from July 2003 until January 2005. Full details of this work can be found in Brown et al (17-18).

Information was recorded from hospital and ambulance notes and included injury descriptions, crash details, restraint status and restraint type. Restraint type was determined from driver interviews and written data in the medical record. Impact severity and impact direction were rated at the scene by ambulance officers, based on the vehicle deformation and witness accounts. Seating position was also noted by the ambulance officers at the scene.

This study included a subset (25%) of in-depth crash investigations. In the in-depth sample, impact parameters such as direction and severity were based on the location and extent of damage to the vehicle. Where possible, impact severity was estimated using the Crash 3 program. Crash severity was rated as low, medium, or high, based on the change of velocity, Δv, or the severity of damage when Δv was not able to be accurately calculated. Crash severity categories were determined as follows:- high (Δv > 60km/hr or equivalent damage severity); medium (40km/h < Δv < 60km/hr or equivalent); and, low (Δv

< 40km/h or equivalent).

Quality of Use	Definition
Appropriate & Correct (Optimal)	Using most suitable restraint for size and using restraint correctly
Appropriate & Incorrect	Using most suitable restraint for size but using restraint incorrectly
Inappropriate & Correct	Not using most suitable restraint for size and using restraint correctly
Inappropriate & Incorrect	Not using most suitable restraint for size but using restraint incorrectly
Suboptimal	Inappropriate and/or incorrect use
Most suitable restraint for size	Up to 18kg: forward facing child restraint (CRS) Height <145cm, Weight > 18kg: Booster

Table 1: Quality of Use Definitions

Quality of restraint use for each child was assessed as appropriate and correct; appropriate and incorrect; inappropriate and correct; and, inappropriate and incorrect as defined in Table 1. Comparisons were made between correctly and incorrectly restrained children regardless of appropriateness. Therefore the incorrectly restrained group consisted of both inappropriate and appropriately restrained children, and likewise the correctly restrained group consisted of both inappropriate and appropriately restrained children.

Injury data were coded using the Abbreviated Injury Scale (1990 revision), and Injury Severity Scores (ISS) were calculated based on these codes. The association between restraint quality and injury outcome was explored in terms of the maximum abbreviated injury score (MAIS) and the injury severity score. Cases were grouped into minor injuries and moderate/serious injuries using MAIS. Minor injury was defined as having a MAIS of less than 2. Moderate/serious injury was defined as having an MAIS equal to or greater than 2. Three levels of injury outcome were investigated using ISS. These were minor injury (ISS >4); moderate injury (ISS>9); and severe injury (ISS>15).The association between restraint quality and injury categories was explored using Pearson's chi-square statistic. Unadjusted Odd Ratio (OR) and 95% confidence intervals (CI) were also estimated for serious injuries by restraint quality, and adjusted for crash severity using the Mantel-Haenszel pooled estimate test.

Ethical approval for this work was obtained from the Human Ethics Committee of the Children's Hospital at Westmead and the Human Research Ethics Committee of the

University of NSW.

Laboratory Work

The laboratory work being presented consists of preliminary studies from a project where real world crashes were reconstructed. Our study of misuse is ongoing with laboratory work simulating the types of misuse identified in the field based investigation study. The aim of this work is to determine the reduction in effectiveness of crash protection introduced by the various forms of incorrect use.

For the purposes of this paper, potential injury mechanisms in children using restraints incorrectly in the most common serious modes of incorrect use observed in the field and crash studies seen to date are presented. These were investigated through a series of 6 laboratory tests. Full details of these tests can be found in Bilston et al (29, 30) and Brown et al (19). A test matrix reproduced from Brown et al (19) is provided in Table 2.

Head accelerations, neck loads and moments measured during these tests have been presented elsewhere (19). The potential injury mechanisms in the modes of misuse studied are demonstrated here through comparisons of dummy motion between the incorrect and correct mode of restraint.

Test	Dummy	Restraint Configuration	Impact Direction	Velocity Change (km/h)	Peak Deceleration (g)
1	HIII 6	Incorrect use of adult lap/sash belt	Full frontal	30.3	15.0
2	HIII 6	Correct use of adult lap/sash belt	Full frontal	31.2	14.7
3	HIII 3	Incorrect use of lap/sash belt with booster	Full frontal	34.5	18.9
4	HIII 3	Correct use of lap/sash belt with booster	Full frontal	34.4	18.9
5	HIII 3	Incorrect use of harness in forward facing CRS	Full frontal	34.0	17.0
6	HIII 3	Correct use of harness in forward facing CRS	Full frontal	33.8	16.9

Table 2: Laboratory Test matrix

Results

Field Misuse Study

Data collection commenced February 2007 and is ongoing. Data collection is expected to be complete by December 2007. To date data has been collected for 135 children (41% female, 59% male) aged 0 – 6 years. The age distribution (in terms of age at next birthday) is shown in Figure 1.

Figure 1: Age distribution among data collected to date

The distribution of restraints seen in the study is shown in Figure 2. All but one child (99%) were using some form of restraint. However, some form of incorrect use was observed in 61% of the cases. The proportion of incorrect use seen in each type of restraint is shown in Figure 3. In looking at Figure 3, note that to date there have only been a small number of children observed to be using rearward facing restraints (8 cases) and child safety harnesses (2 cases). Some form of incorrect use was observed in 5 of the 8 rearward facing infant restraints, and both child safety harnesses seen thus far. Among the other types of restraint, the greatest proportion of incorrect use is occurring in forward facing restraints (65%), followed by booster seats (60%). Children using adult seat belts are demonstrating the lowest levels of incorrect use (48%), but even in this type of restraint, incorrect use is being observed in almost half of the children.

Note that incorrect use associated with installing the restraint and associated with using the restraint is lumped together in this analysis. Later analyses conducted with the complete data set will separate this out.

Figure 2: Restraint Type Distribution

Preliminary classifications of the severity of the incorrect use have been undertaken. Using these classifications of minor, moderate and serious incorrect, the severity of incorrect use by restraint type is shown in Figure 4. This shows that about 50% of the incorrect use seen in forward facing child seats and rear ward facing infant restraints is minor. In contrast, much less of the incorrect use seen in seat belts and boosters is minor, with more than 50% having potentially serious consequences in a crash.

Figure 3: Incorrect Use by Restraint Type

Figure 4: Severity of Incorrect Use by Restraint Type

Of those small numbers of rearward facing infant restraints seen so far, the 2 cases of incorrect use have involved; (i) a twisted and slightly loose internal harness (classified as minor severity) and,

(ii) a restraint where there was no seat belt used to anchor the restraint (classified as serious incorrect use).

Both child safety harnesses seen in the sample so far were being used incorrectly. In one case the harness had been over tightened so that the lap belt sat high across the child's abdomen (classified as moderate severity). In the other case the harness had been over tightened in a similar manner but in this case, the lap belt was also extremely loose (classified as serious incorrect use). Both forms of incorrect use would increase the risk of submarining and abdominal injury in a frontal crash.

Examples of the types of incorrect use and their preliminary severity classifications for forward facing child restraints, boosters and seat belts are shown in Table 4, 5 and 6 respectively.

Minor	**Moderate**	**Serious**
Slightly loose harness	Moderately loose harness	Very loose harness
Shoulder height problem	Slack in top tether	No belt anchoring seat
Baby liner still in use*	Moderate belt routing problem	Shoulder straps so low not on shoulder
Rebound bar still in place*	Slack in belt system	No top tether
Seat belt locker not activated*	Twist in top tether	Seat belt not engaged
Seat belt locker not used*	Seat belt loose	Arms completely out of harness
Plastic keepers on harness not used*		Problem with top tether anchorage
Seat belt fouling harness		
Gated buckle used incorrectly*		

Table 3: Incorrect Use in Forward Facing Child Restraints (*assumed to be minor – impact needs to be tested in laboratory)

Minor	**Moderate**	**Serious**
Twisting of belt	Not using lap belt guide	Positioning of sash over or under arm
No top tether*	Sash guide not being used	Not using sash
Top tether problem*		Anti-submarining clip not used
Using harness when not suitable*		Sash guide placed incorrectly resulting in poor fit

Table 4: Incorrect Use of Booster Seats (*assumed to be minor – impact needs to be tested in laboratory)

Minor	**Moderate**	**Serious**
Twisting of belt	Slack in belt system	Sash not being used or being used incorrectly

Table 5: Incorrect Use of Seat Belts (*assumed to be minor – impact needs to be tested in laboratory)

Real World Study

From the retrospective review of crashes there were 142 restrained children for whom correctness of restraint use could be determined and who sustained an injury. Of these 5% were identified to have been using their restraint incorrectly. Across this sample, one quarter of the children sustained moderate to severe (AIS 2+) injuries. In terms of ISS, 25% scored over 4 (ISS>4); 15% scored over 9 (ISS>9); and 10% scored over 15 (ISS>15).

Comparing injury outcomes for correctly and incorrectly using their restraints, there were significantly more children moderately to seriously injured when using their restraints incorrectly ($p<0.05$, unadjusted OR 8.8 95% CI 1.6–47.8, adjusted OR 6.9, 95% CI 1.7-41.4). There were also significantly more incorrectly restrained children with an ISS>15 ($p<0.05$). Adjusting for crash severity, incorrectly restrained children were 7 times more like to sustain life threatening injuries (ISS>15) than those using their restraints correctly (95% CI 1.1-39.6).

There was also a greater proportion of head and spinal injuries among those incorrectly restrained (unadjusted OR for head injury in incorrectly restrained 10.5, 95% CI 1.2–90.3, adjusted 11.0 5% CI 0.92–130.8; unadjusted OR for spinal injury 6.8, 95% CI 1.4–33.1, adjusted OR 6.3, 95% CI 1.2–32.2).

All cases of incorrect use seen in this sample involved serious forms of incorrect use. This involved failure to correctly use the internal harness system of a forward facing child restraint, or the sash part of the adult belt (while using a booster seat of an adult belt alone);and, in one case a forward facing child restraint was not correctly attached to the vehicle.

In all but one case there was evidence of head contact. In two children this resulted in severe brain injury. High spinal injuries were sustained by three of the children aged less than 5 years. In one 7 year old child for whom incorrect use was identified, there were significant lumbar spine fractures and associated abdominal injury, as well as evidence of head contact. Intrusion was not a factor in any of these crashes. All involved frontal impacts and children seated in the rear.

Three example cases have been selected to exemplify the potential catastrophic consequences of serious modes of misuse. These cases illustrate serious modes of incorrect use in a forward facing child restraint, a booster seat, and an adult belt.

Case 1: Forward Facing Child Restraint

This 2 year old child sustained a complete transaction of the spinal cord at C4 resulting in death together with external bruising under the left chin and over the left flank. The internal harness system of the restraint was being used incorrectly (excessive slack and possibly one arm out). The child was seated in the left rear seat.

The vehicle in which the child was travelling was involved in a head-on collision with a similar sized passenger vehicle. The impact was offset to the right, and the Δv was estimated to be approximately 60km/h. This resulted in substantial damage to the front of the vehicle involving the front bonnet, A pillar, driver's door, and B pillar. There was no intrusion in the child's seating position, and this compartment remained relatively intact. The child's injuries occurred as a direct result of the excessive upper torso and head excursion allowed from the incorrect use of the harness. The most serious injuries sustained by the elderly adult front seat occupants were multiple rib fractures. Had this child been correctly using the internal harness, it is unlikely there would have been any significant injuries.

Case 2: Booster Seat

This 4 1/2 year old was appropriately using a booster seat in the left rear of vehicle that was involved in a high severity impact with a heavy vehicle. The child's vehicle crossed onto the wrong side of the road when the driver fell asleep while travelling at 80- 90km/h, and partially under rode the front of an oncoming truck. While there was substantial damage to the vehicle and significant compromise of the front seat compartment, the rear seating positions remained fully intact. The front seat driver was injured but survived with relatively moderate injuries. However the child sustained extensive life threatening head and spinal injuries. The booster's sash guide was tied down to a luggage tie-down point separate to the booster seat. During the impact, this resulted in the sash being pulled from the child's shoulder, and there was no effective restraint of the upper torso. This child's injuries were a direct result of the excessive upper torso and head excursion allowed by this form of misuse. As in Case 1, had this child been correctly restrained it is unlikely such serious injuries would have occurred.

Case 3: Adult Belt

This child was almost 8 years old and using a lap sash seat belt in the right rear. The vehicle in which the child was travelling was involved in a speed, high severity frontal impact with another passenger vehicle. The injuries sustained included a swollen lip and a loose tooth indicating a head contact. The child also sustained grazing over the upper abdomen indicative of a sash that had been incorrectly placed under the right arm rather than over the middle of the right shoulder. This was associated with underlying internal abdominal injury together with lumbar spine fracture with rupture of spinal ligaments and spinal nerve root damage.

Laboratory Work

Full results from the six laboratory tests being presented here have been presented elsewhere (19). These tests were conducted to simulate outcomes in correctly and incorrectly used restraints. The modes of incorrect use simulated replicate those serious modes observed in both the field inspection and crash studies and illustrated above.

Forward Facing Child Restraints – Failure to use internal harness correctly

This test compared the differences in motion observed during a frontal impact when the internal harness of a forward facing child restraint is used correctly and when it is not. A Hybrid III 3 year old dummy is used as a surrogate for a 3 year old child. The incorrect use simulated involved non use of one shoulder harness. This form of incorrect use resulted in the head of the dummy being allowed to travel a greater distance. This is demonstrated in the comparison of head displacement shown in Figure 5.

Figure 5: Comparison of head displacement in a correctly and incorrectly used forward facing restraint. The serious from of incorrect use simulated results in greater head excursion.

Still photographs from the point of maximum excursion taken from high speed video are shown in Figure 6. These illustrate how this form of incorrect use results in a greater risk of head and neck injury. Head contact occurs when the head and neck are in tension, and explains the catastrophic high spinal injuries observed in the field with this form of misuse.

Figure 6: Comparison of motion at point of maximum excursion in a correctly and incorrectly used forward facing restraint. The serious from of incorrect use simulated results in the head and neck being at a greater risk of injury.

Booster Seats – Failure to use sash correctly

Excessive upper torso and head motion also occurs with incorrect belt use in a booster seat. See Figure 7. This test illustrates the difference in protection provided to a surrogate for a 6 year old child using a booster seat when the sash part of the adult seat belt is and is not used correctly.

Figure 7: Comparison of head displacement in correctly and incorrectly used booster seats. The serious from of incorrect use simulated results in greater head excursion.

The resulting motion is shown Figure 8. Contact with the seat in front prevents extreme upper body flexion around the lap portion of the belt, but the head contact that occurs while the neck is in tension explains the potential for catastrophic upper spinal injuries as seen in the field with this form of misuse.

Figure 8: Comparison of motion at point of maximum excursion in a correctly and incorrectly used booster seat The serious from of incorrect use simulated results in the head and neck being at a greater risk of injury.

Seat belts – Failure to use sash correctly

This test compares the motion of a Hybrid III 6 year old dummy in an incorrectly and correctly worn adult lap/sash belt. From Figure 9 it is clear that this form of incorrect use also results in greater head excursion.

Figure 9: Comparison of head displacement in a correctly and incorrectly used adult belt. The serious from of incorrect use simulated results in greater head excursion.

However, as shown in Figure 10 it there is also substantially more upper body flexion when the lap-sash belt is worn incorrectly. The lack of effective upper torso restraint acts to concentrate the seat belt loads across the abdomen like a lap only belt and explains the abdominal and lumbar spine injuries seen in the field study.

Figure 10: Comparison of motion at point of maximum excursion in a correctly and incorrectly used adult seat belt. The serious from of incorrect use simulated results in greater head and upper torso motion and a greater a greater risk of head, abdominal and spine injury.

Discussion & Conclusions

While using some form of restraint reduces the chance of being injured in a crash, sub-optimal restraint reduces the level of protection provided. There are two forms of sub-optimal restraint; inappropriate restraint choice and the incorrect use of a restraint system. Other studies conducted by our group and others (24-26) have reported that inappropriate use is widespread among Australian children. Based on the preliminary observations from this ongoing field study of misuse currently being conducted in NSW, it appears that a substantial proportion of children aged 1 – 6 years are also using their restraints incorrectly.

Current educational strategies and proposed legislative changes are aimed at reducing inappropriate use and encouraging child occupants to use the most suitable form of restraint for their size. The preliminary observations regarding incorrect use indicate that there is need to address not only the types of restraint being used, but the way in which restraints are used. This is particularly important in the current climate. The goal of proposed legislative changes regarding the type of restraints used by child occupants is to reduce child occupant casualties. Unless the level of incorrect use can be kept to a minimum, such measures will not achieve significant results. In 2004, Desapriya et al investigated the effectiveness of legislation requiring the use of child restraints for children up to 5 years introduced into Japan in 2000. These authors found there was no reduction in casualty numbers following the introduction of this legislation citing incorrect use as a likely reason.

The preliminary results from our misuse field study indicate that there are a range of misuse types occurring. In forward facing child restraints most incorrect use would have only minor implications in a crash. In contrast, most of the incorrect use seen in booster seats has the potential for serious consequences in a crash. More detailed analysis in this regard will be conducted when data collection is complete. These results will assist in prioritizing the modes of incorrect use that need to be addressed. From the preliminary observations, and the observations from our crash and laboratory studies it is clear however that there is a need to develop countermeasures against the incorrect use of the internal harness in forward facing seats, and the sash when using booster seats or adult belts alone.

There are primarily two current countermeasures for incorrect child restraint use operating in Australia. The Child Restraint Fitting Station Network was designed specifically as a countermeasure to incorrect use and has been operating since 1985. The Restraint Fitting

Station Network targets problems associated with the correct fitment of restraints into vehicles. There is also scope for this network to be a source of information related to the correct securing of a child within a restraint system. In a recent random telephone survey of approximately 400 homes in NSW with 615 children aged 10 or younger, parents and carers were asked about their use of the Fitting Station Network. Two thirds of parents/carers of children using rearward facing restraints reported getting assistance from a fitting station; but only just over half of forward facing restraints users, and approximately 20% of booster seat users (Brown et al, unpublished data). This suggests there is scope for more widespread use of this resource, both in terms of providing correct installations and correct usage information. Use of the fitting station network is being recorded in this current study, to determine whether this reduces restraint misuse.

Since its inception, the Australian Child Restraint Evaluation Program (CREP) has included an assessment of the usability of child restraints. A recent review of the assessment procedures used in the program recommended major enhancements to the procedures. These changes were adopted, and the most recent series of CREP includes the updated ease of use assessments (28). The aim of the ease of use assessments in CREP is to encourage manufacturers to simplify methods of restraint installation and the way a child needs to be secured within a restraint. Moreover, it is hoped that design based strategies will be developed to provide restraint systems that are difficult to use incorrectly.

For CREP to be effective, consumers must be well informed of the purpose of the program and the results of the evaluations. Widespread promotion of CREP results is a strategy that could be adopted by practitioners as a countermeasure to incorrect use. This would also work to educate consumers of the importance of the correct use of restraints. In the longer term, preventing incorrect use is likely to be most effectively achieved through changes to restraint design. There is a continuing need for the investigation and development of restraint designs that not only minimize the propensity for incorrect use but actually prevent incorrect use. Such features could include reminders, indicators, self-adjusting harnesses, just to name a few. Alternatively, requirements for such features could be introduced through amendments to Australian Standards and possibly Australian Design Rules related to vehicles.

In conclusion, the observations being made in the field by our group highlights the need for urgent increased attention to the problem of incorrect use. In particular results obtained to date suggest that the way children use the internal harness of child restraint systems and the sash belt of adult seat belt systems (either alone or in combination with a booster) require immediate attention. Failure to educate parents on the correct use of restraints could potentially negate the benefits of appropriate restraint use laws and guidelines.

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