Peer Reviewed Papers

Child restraint misuse: Incorrect and inappropriate use of restraints by children reduces their effectiveness in crashes

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This paper was originally presented under the title ' Misuse of Child Restraints and Injury Outcome in Crashes' at the Australasian Road Safety Research, Policing and Education Conference held at Surfers Paradise, Queensland, 25-27 October 2006.

Abstract

It is well known that restraining children in cars reduces their risk of injury in a crash. However, sub-optimal restraint use reduces restraint effectiveness. While the most common form of sub-optimal use is inappropriate use, incorrect use of a restraint has potential for more severe outcomes. This paper draws on field data and studies injury mechanisms through laboratory simulations. Field data is drawn from a dataset of children aged 2-8 in crashes. Laboratory simulations of a number of these crashes were used to study injury mechanisms. Only a small proportion of children in the field sample (5%) were incorrectly using a restraint system, however most of these children (5 out of 7) sustained moderate to severe injuries. This was significantly different to what occurred in the children correctly using restraints. Most incorrect use was seen in children under 5. Most cases involved misuse of the internal harness system of forward facing restraints or the adult belt (with or without a booster). The laboratory study showed an increased injury potential resulting from excessive head and torso excursion in incorrectly used restraint systems. This paper discusses these findings with respect to current restraint system design and calls for an increase in the amount of attention paid to this issue.

Introduction

There is no doubt that a restrained child is offered more protection then an unrestrained child in a crash. However, recent research has demonstrated that the highest levels of protection are provided when the child uses the optimal form of restraint available.(1-8)

Optimal restraint requires two things. It requires that the restraint being used is of a type that is the most appropriate for the child's size, and that the restraint being used is being used correctly. Sub-optimal restraint therefore encompasses inappropriate restraint use and incorrect restraint use. Inappropriate restraint use is the most widespread form of sub-optimal restraint use and has received substantial attention in recent years. (2-4, 8-10, 24). This has resulted in the implementation of educational and legislative strategies in numerous jurisdictions to increase the use of appropriate restraint systems by child occupants.

Incorrect use has received far less attention, however most studies of children in crashes cite incorrect use of restraints as a major source of injury (7, 11-20). Exactly how widespread incorrect use is in the general population is difficult to determine. 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, convenience sample based observational surveys have shown that about 80% of child restraints were not being used as intended (21).

There are primarily two distinct categories of incorrect use: - incorrect installation of the restraint in a vehicle, and incorrect placement of a child within a restraint. An Australian study of child restraint installations conducted in a convenience sample (17) 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.

Different types of incorrect use can have different effects on restraint performance in crashes. Laboratory studies have demonstrated that some forms of incorrect use may have little impact on the performance of a restraint system while others appear to be extremely deleterious to restraint performance (15, 22, 23).

This paper describes the types of incorrect restraint use seen in a field study of children in crashes conducted in NSW, Australia, and compares the outcomes of children incorrectly restrained with the outcomes of children using other forms of sub-optimal restraint. Potential injury mechanisms in children incorrectly using restraints has also been studied in the laboratory by our group and results relevant to the primary forms of incorrect use seen in the field are presented here as well.

Methodology

A sample of 152 children involved in crashes was collected through a previous retrospective review of all child occupants aged 2-8 years who presented to a paediatric emergency department following crash involvement from July 2003 until January 2005, Analysis of this total sample, that includes 47 cases collected through in-depth investigation and 105 collected through case review has been reported elsewhere (2-3). For this current analysis all restrained children for whom quality of restraint use could be determined in that original sample were extracted. This includes 47 in-depth cases and 95 from case review. Information recorded included injury descriptions, crash details, restraint status and 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 damage and witness accounts. Seating position was also noted by the ambulance officers at the scene. For a subset of cases (30% of the entire original sample) full in-depth crash investigation was conducted.

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

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. Appropriate/inappropriate use was determined using the heights and weights of the child occupants as reported in parental interviews or recorded within the medical record. Where no height was available, weight alone was used. Where no height or weight data was available, age in months was used in combination with paediatric growth charts (27) to estimate weight. While the use of booster seats by children between 14 and 18 kg may be in accordance with the design range set by the Australian Standard for Child Restraints, optimal restraint practice involves delaying transitions for as long as possible (26), therefore the lower limit of 18kg was used in the assessment of appropriate booster seat use. The upper limits for booster seat appropriateness were based on the findings of Klinich et al (28), that good adult belt fit is rarely achieved before a height of 145cm. As a 95th percentile 8 year old male is 138cm tall (27), it was concluded that eight year olds would not be tall enough to achieve good adult belt fit, unless known height was greater than 145cm. Correct/incorrect use was determined through vehicle and restraint inspections (in the in-depth sample); and misuse descriptions recorded by ambulance officers (in the case review).Quality of use assessments were not made blind to injury outcome as the criteria and methods used to rate quality of use were independent of injury outcome. Comparisons were made between inappropriately and appropriately restrained children with all cases of incorrect use removed; correctly and incorrectly restrained children regardless of appropriateness; and, inappropriately and incorrectly restrained children. In the latter, the appropriately restrained group consisted of only those children correctly and appropriately restrained. The incorrectly restrained group consisted of both inappropriate and appropriately restrained children.

All tests were conducted on a rebound crash sled. Test 1 and 2 used the Hybrid III 6 year old dummy and adult lap sash seat belt. Test's 3-6 were conducted using the Hybrid III 3 year old dummy. In test 3 and 4 the dummy was restrained with a high back booster and in tests 5 and 6 the dummy was restrained in a forward facing child restraint system (CRS). For each type of

Quality of Use	Description	Definition
Optimal	Appropriate & Correct	Using most suitable* restraint for size and using restraint correctly
Sub-optimal	Appropriate & Incorrect	Using most suitable restraint for size but using restraint incorrectly
Sub-optimal	Inappropriate & Correct	Not using most suitable restraint for size and using restraint correctly
Sub-optimal	Inappropriate & Incorrect	Not using most suitable restraint for size but using restraint incorrectly

Table 1: Quality of Use Definitions (*Most suitable restraint defined as follow: Up to 18kg: forward facing child restraint (CRS);Height <145cm, Weight > 18kg: Booster)

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

restraint, one test was conducted with the restraint being used correctly and one test was conducted with a form of incorrect use seen in the field study.

Head accelerations, neck loads and moments were recorded. High speed video (at 1000 frames per second) was used to observe dummy kinematics and measure head excursion. Data acquisition was performed by an Applied Measurement signal conditioner at 10 kHz in accordance with SAE J211/1 standards. Each data channel was filtered using the Channel Frequency Class (CFC) filter class specified in SAE J211/1. Comparisons between the incorrect and correct mode of restraint were made on dummy motion and head displacement. Analysis of these and other reconstructions has indicated head acceleration and neck load data are limited in their usefulness (25).

Results

There were a total of 142 restrained children for whom quality of restraint use could be determined. The age range of these children was 2 years to 8 years. There were slightly more males (60%) than females (40%).. Most children (82%) were sub-optimally restrained. This included 78% who were using an inappropriate restraint for their size, and 5% who were using their restraint incorrectly. Two percent were using an inappropriate restraint incorrectly.

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).

Quality	**Restraint**	MAIS <2	MAIS ≥4	Total
Appropriate	Booster	7	0	7
	FFCRS	15	0	15
	S/Harness	3	0	3
Inappropriate	**Lap Sash**	68	23	91
& Correct	Lap	3	4	7
	Booster	9	2	11
	S/Harness	0	1	1
Appropriate	**Booster**	0	1	1
& Incorrect	FFCR	1	2	3
Inappropriate	Lap Sash	1	1	2
& Incorrect	Booster	0	1	1
	Totals	107	35	142

Quality	**Restraint**	ISS <9	ISS ≥9	Total
Appropriate	Booster	7	0	7
	FFCRS	15	0	15
	S/Harness	3	0	3
Inappropriate	Lap Sash	78	13	91
& Correct	Lap	5	2	7
	Booster	9	2	11
	S/Harness	1	0	1
Appropriate	Booster	0	1	1
& Incorrect	FFCR	2	1	3
Inappropriate	Lap Sash	1	1	2
& Incorrect	Booster	0	1	1
	Totals	121	21	142

Quality	**Restraint**	ISS <4	ISS ≥4	Total
Appropriate	Booster	7	0	7
	FFCRS	14	1	15
	S/Harness	3	0	3
Inappropriate	Lap Sash	68	23	91
& Correct	Lap	3	4	7
	Booster	9	2	11
	S/Harness	0	1	1
Appropriate	Booster	0	1	1
& Incorrect	FFCR	2	1	3
Inappropriate	Lap Sash	1	1	2
& Incorrect	Booster	0	1	1
	Totals	107	35	142

Quality	**Restraint**	ISS <15	ISS ≥15	Total
Appropriate	Booster	7	0	7
	FFCRS	15	0	15
	S/Harness	3	0	3
Inappropriate	Lap Sash	85	6	91
& Correct	Lap	6	1	7
	Booster	9	2	11
	S/Harness	1	0	1
Appropriate	Booster	0	1	1
& Incorrect	FFCR	2	1	3
Inappropriate	Lap Sash	2	0	2
& Incorrect	Booster	0	1	1
	Totals	130	12	142

Table 3: Quality & Type of Restraint Use By Injury Outcome

Comparing the injury outcome for children using inappropriate and appropriate restraints (with all cases of incorrect use removed from the analysis), no child appropriately restrained sustained an AIS 2+ injury, while injuries of this severity were sustained by 28% of those inappropriately restrained. This difference was statistically significant ($p<0.05$). However, the lack of AIS 2+ injuries in the appropriately restrained children prevents the estimation of ORs. The OR for sustaining an injury greater than ISS 4 (ISS>4) could be estimated and this revealed children inappropriately restrained were more likely to sustain at least a minor injury compared to those appropriately restrained. However this difference did not quite reach significance when crash severity was controlled for (unadjusted OR 9.0, 95% CI 1.2– 69.5; adjusted OR 7.3, 95% CI 0.99– 58.3). In the more severe injury categories (ISS>9 and ISS>15), there was no significant difference between children inappropriately and appropriately restrained. See Table 4

To ensure the difference in injury outcome observed was related to restraint quality rather than restraint type, the injury outcome between children restrained in dedicated child restraints and children restrained in adult seat belts was examined regardless of the child's size (i.e restraint appropriateness). This revealed no significance difference in injury outcome, with similar proportions of children sustaining moderate to severe injuries (AIS 2+) in adult belts (27%) and child restraints (20%). Similar results were observed using ISS as a measure of injury outcome.

For children correctly and incorrectly using their restraints, there were proportionally more children moderately to seriously injured when using their restraints incorrectly (57%) than when using their restraints correctly (22%) ($p<0.05$, 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 (43%) than correctly restrained (7%) ($p<0.05$). 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). See Table 4. However the absolute number of children identified incorrectly restrained in this sample was small (n=7).

Of the different forms of sub-optimal restraint, children using their restraints incorrectly sustained a greater proportion of serious injuries (AIS 2+) than the children using inappropriate restraints ($p<0.05$), but this difference did not quite reach

	AIS2+				**ISS>4**			
	unadjusted		**adjusted**		**unadjusted**		**adjusted**	
	OR	**CI**	**OR**	**CI**	**OR**	**CI**	**OR**	**CI**
Incorrect v correct	8.8	1.6-47.8	6.9	1.7-41.4	4.3	0.92-20.4	3.5	0.63-19.6
p value	0.010		0.066		0.067		0.145	
Incorrect v inappropriate	6.7	1.2-36.2	5.4	0.92-31.8	3.6	0.75-16.8	2.8	0.5-16.1
p value	0.025		0.151		0.191		0.163	
Inappropriate v appropriate* -					9.0	1.2-69.5	7.3	0.99-54.3
p value	0.001		0.082		0.015		0.074	
	ISS>9				**ISS>15**			
	unadjusted		**adjusted**		**unadjusted**		**adjusted**	
	OR	**CI**	**OR**	**CI**	**OR**	**CI**	**OR**	**CI**
Incorrect v correct	4.6	0.96-22.3	3.5	0.63-19.0	8.5	1.7-43.0	6.9	1.2-39.1
p value	0.074		0.114		0.021		0.031	
Incorrect v inappropriate	4.1	0.84-20.0	3.0	0.53-17.1	8.4	1.6-43.6	6.7	1.1-39.6
p value	0.096		0.157		0.023		0.044	
Inappropriate v appropriate* -	-	- -	-	- -	-			
p value	0.312		0.061		0.688		1.000	

*Odds ratio could not be estimated due to no AIS2+ among appropriately restrained children

Table 4: Association between different forms of sub-optimal restraint and injury with and without adjustment for impact severity

significance when crash severity was controlled for (unadjusted OR 6.7, 95% CI 1.2– 36.2; adjusted OR 5.4, 95% CI 0.92– 31.8). However, the incorrectly restrained children were more than 6 times more likely to sustain life threatening injuries (ISS>15) (unadjusted OR 8.5, 95% CI 1.7– 43.6; adjusted OR 6.7, 95% CI 1.1-39.6). See Table 4 and Figure 1.

A detailed summary of the crash and restraint details for each child incorrectly using a restraint is provided in Table 6. From this table the potentially life threatening nature of the injuries sustained by children incorrectly using restraints is clear. In all but one case there is evidence of head contact. In two children this has resulted in severe brain injury. High spinal injuries were sustained by three of the children aged under 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.

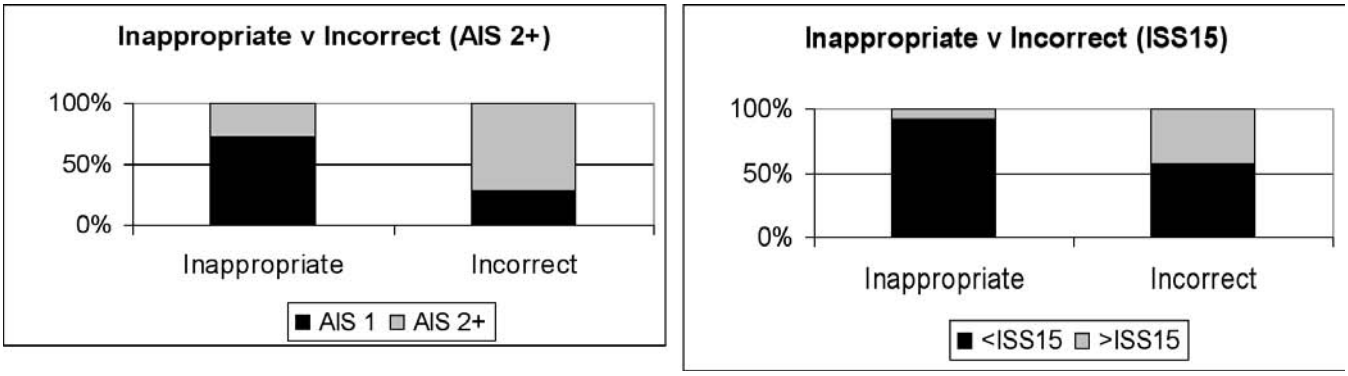

Figure 1: Injury severity in inappropriately and incorrectly restrained children

Unadjusted	Head Injury	Spinal Injury	Chest Injury	Abdominal Injury	Extremity Injury
OR	10.5	6.8	0.49	2.1	0.98
CI	1.2-90.3	1.4-33.1	0.06-4.2	0.39-10.7	0.11-8.7
P value	0.014	0.023	0.445	0.332	0.731

Adjusted	**Head Injury**	**Spinal Injury**	**Chest Injury**	**Abdominal Injury**	**Extremity Injury**
OR	11.0	6.3	0.49	1.8	0.59
CI	0.92-130.8	1.2-32.2	0.05-4.4	0.34-9.5	0.06-5.7
P value	0.059	0.013	0.657	0.529	0.609

Table 5: Pattern of injury in incorrectly restrained children and inappropriately restrained children

There was also a difference in the pattern of injury observed between those children injured while inappropriately restrained and those children incorrectly restrained (p<0.05). In particular, there was 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). See Table 5.

Six laboratory tests were conducted to simulate outcomes in correctly and incorrectly used restraints. Head displacements measured in each test are shown in Figure 3. Still frames from the point of maximum excursion are shown in Figure 2.

Child No	Child Details (sex)	Restraint Type	Misuse	Crash Details (severity)	Seat Position	Injury Description	MAIS
1	4yrs 5mths 20kg (M)	Booster with lap sash seat belt	Sash part of belt not being used correctly	Two vehicle frontal impact (H)	Left rear	Brain haemorrhage (SAH). Atlanto-occipital dislocation with cord odema. Fractures C6-7 T1-4, T7. Bilateral lung contusions.	4
2	2yrs Wgt unk (F)	Forward Facing CRS	Left arm and shoulder not in harness	Two vehicle frontal impact (H)	Left rear	Abrasion left jaw. Atlanto-occipital dislocation with spinal cord transection at C4.Contusion left flank	6
3	2yrs Wgt unk (F) 2yrs 5mths 12kg (M)	Forward Facing CRS	Restraint not correctly attached to vehicle	Two vehicle frontal impact (H)	Third row rear	Hematoma right forehead. Lacerated tongue	1
4	3yrs 8mths 17kg (M)	Forward Facing CRS	Very loose shoulder harness	Two vehicle frontal impact (M)	Right rear	Extensive laceration right cheek extending to forehead. Contusion left forehead.	2
5	4yrs 5mths Wgt unk (M)	Adult lap sash seat belt	Arm out of sash	Two vehicle frontal impact (L)	Right rear	Diagonal seat belt abrasions upper abdomen	1
6	7yrs 7 mths Wgt unk (F)	Adult lap sash seat belt	Arm out of sash	Two vehicle frontal impact (H)	Right rear	Swollen lips, loose tooth. Grazing left upper abdomen; bruises right lower abdomen; internal abdominal injury; lumbar spine fracture with rupture of spinal ligaments and spinal nerve root damage	2
7	2 Yrs Wgt unk (M)	Booster with lap sash seat belt	Arm out of sash	Two vehicle frontal impact (H)	Right rear	Right facial laceration, brain injury, cervical spinal ligament damage; bowel injury	4

Table 6: Summary of cases involving children incorrectly using their restraints

** Intrusion refers to intrusion into the child's occupant space Abbrieviations: Wgt = Weight; Unk = Unknown; Yrs = Years; Mths = Months F = Female; M = Male; L = Low severity; M=Medium severity; H=High severity

Incorrectly worn adult lap sash belt

Incorrect belt use with booster seat

Incorrect harness use with forward facing CRS

Correctly worn adult lap sash belt

Correct belt use with booster seat

Correct harness use with forward facing CRS

Figure 2: Dummy motion in correctly and incorrectly used restraints

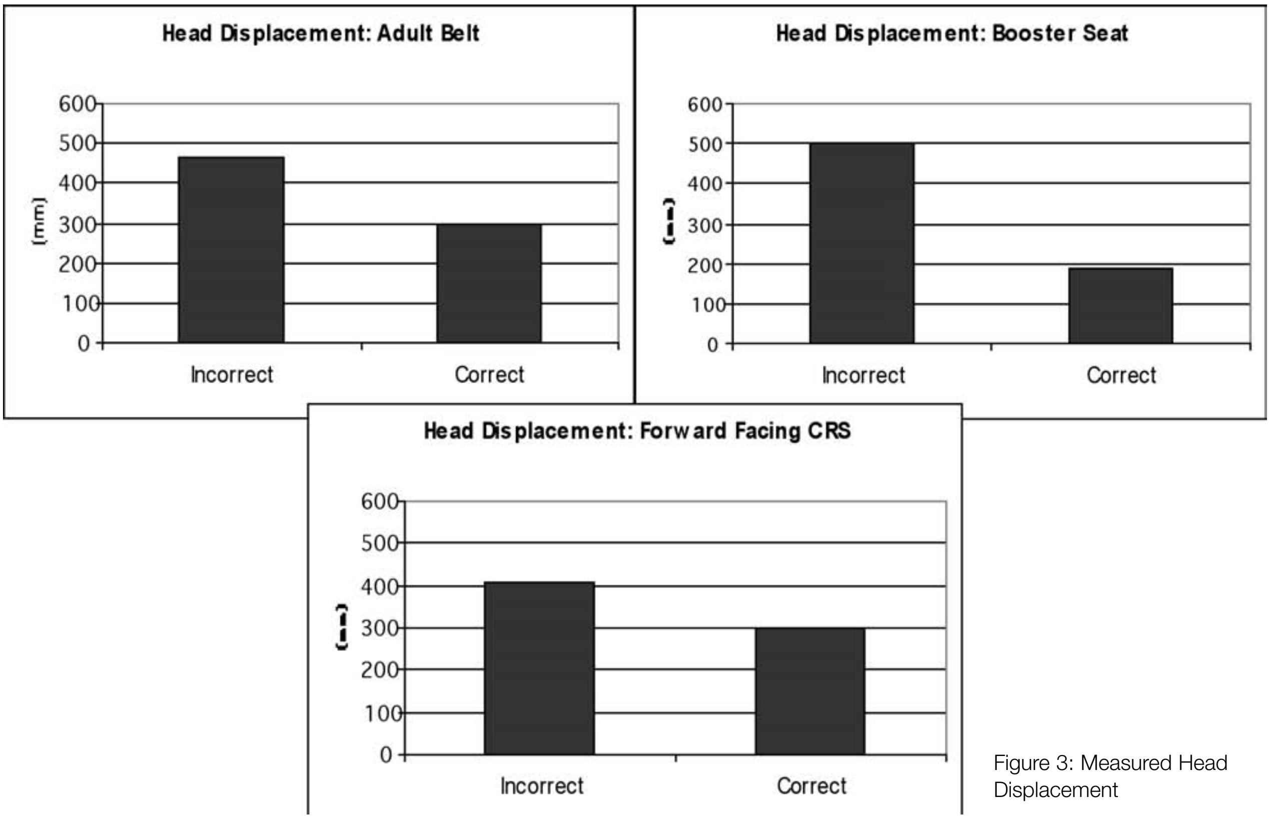

Figure 3: Measured Head Displacement

Tests 1 and 2 compare the motion of a Hybrid III 6 year old dummy in an incorrectly and correctly worn adult lap sash belt. From Figure 2 it is clear that there is 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 type of injuries seen in the 7 year old seen in the field study (Case 6,Table 6). Measured head displacements and photographs in Figure 2 and Figure 3 demonstrate the extra head motion that also occurs when the belt is worn incorrectly.

Excessive upper torso and head motion also occur with incorrect belt use in a booster seat. (Tests 2 and 3, Figure 2 and Figure 3). Contact with the seat in front prevents the extreme upper body flexion around the lap portion of the belt, but the head contact while the neck is in tension explains the potential for life threatening upper spinal injuries as seen in the field with this form of misuse (Case 1,Table 6). Similarly, non use of one shoulder harness of a forward facing child restraint also results in the head being allowed to travel a greater distance. See Figure 2 and Figure 3. 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. (Case 1, Table 6).

Discussion & Conclusions

Inappropriate use of restraint, particularly premature graduation to adult seat belts and booster seats is the most widespread form of sub-optimal use seen in the field (2-4, 6-8, 19, 24-25). From a population based sample, , Durbin et al (3) demonstrated that for children aged 4 to 7, the odds of injury when using booster seats is 59% lower than when using adult belts.

For children aged between 1 and 4 years, Arbogast et al (1) in a similar sample demonstrated a reduction of 78% in the odds of injury in children using forward facing child restraints compared to adult seat belts. This together with previous Australian work (2-3, 19) supports educational and legislative moves to encourage children to use the most appropriate form of restraint for their size.

Incorrect use of restraints by children may be a less common form of sub-optimal, however, results presented here, suggest the outcome for children using their restraint incorrectly is potentially more serious. While the limitations inherent in the data collection and analysis of the field data presented here (and discussed in more detail below) are such that the increase in the odds ratio of moderate to severe injury must be viewed with some caution, our findings in the laboratory support an increased injury potential in incorrectly used restraints. This injury risk is due to excessive head and upper torso motion that is allowed when restraints are used incorrectly. This emphasises the need for child safety advocates to keep strategies aimed at minimizing and preventing the incorrect use of restraints by children at a high priority. This is particularly important given that if countermeasures to the inappropriate restraint problem are effective more children will move into dedicated child restraint systems. There may be a need for simultaneous development and implementation of countermeasures targeting incorrect use with strategies aimed at reducing inappropriate use.

Incorrect use of restraints is not a new phenomenon. In 1985, the Traffic Authority of NSW initiated a Child Restraint Fitting Station Network as a specific countermeasure to incorrect use. This network has now spread to most states within Australia. While fitting stations provide many services, their primary role is providing assistance with the correct fitment of restraints into vehicles and they can do little, besides some basic education, to ensure the correct securing of a child within a restraint system. There is a need to develop new countermeasures against misuse, particularly against misuse associated with the incorrect securing of children within restraints.

Simplifying methods of restraint installation and the way a child needs to be secured within a restraint is a long-standing strategy aimed at reducing incorrect use. This is a strategy that has been employed by Standards Australia in the development of the Australian Child Restraint Standard. Assessing the usability of child restraints has also been part of the Australian Child Restraint Evaluation Program (CREP) since its inception in 1992. More recently, following a review of the assessment procedures used in CREP, an enhanced method for evaluating ease of use, and the propensity for misuse, has been introduced into CREP. This method, based heavily on a North American method, aims to encourage manufacturers 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 need for the investigation and development of restraint designs that not only minimise the propensity of incorrect use but actually prevent incorrect use. Alternatively, requirements for such features could be introduced through amendments to Australian Standards and possibly Australian Design Rules related to vehicles.

Finally it is important to discuss a number of issues concerning the methods used in this analysis. Most booster seats in Australia have a lower weight range that overlaps with the upper weight range of forward facing seats. e.g. the upper weight limit for forward facing seats is 18kg, while the lower weight limit for most booster seats is 14kg. The use of booster seats by children between 14 and 18 kg may therefore be within the design range but have been judged sub-optimal based on current best practice guidelines (27). While there were a number of children assigned to the inappropriately restrained group who fell within this weight range overlap, only 3 of these children were using booster seats. The remainder were using adult seat belts. Using the Standards defined weight range for classifying inappropriate use of boosters would therefore have made little difference to the overall results.

Inappropriate and appropriate restraint judgements were made in the same way for all children in this sample (regardless of whether they were collected through in-depth investigation or case review). Incorrect restraint use judgements required more information and were made only when these details was available. The number of children reported to be incorrectly using restraints is therefore likely to be a conservative estimate. This has also resulted in only a small number of incorrect cases being used in this analysis and a high possibility that some cases of incorrect use may have been missed. This may have some affect on the results presented and is reflected in the fairly wide confidence intervals presented with estimations of the odds ratios for serious injury. However there is no systematic difference in how incorrect use was determined depending on injury outcome.

The data represents a convenience sample of children in crashes collected after attendance at hospital emergency departments. This sample does not represent all children in crashes as children from extremely minor impacts may not attend hospital. Conversely child occupants that die on the scene will not always be admitted to a hospital. Therefore the findings from the field cannot be generalized to all crashes involving children. Furthermore, the accuracy of data collected through case review alone is less than that collected through in-depth investigation. The accuracy of the case review data was evaluated by comparing the data collected through case review alone with data collected from in-depth investigation in a subset of cases. There was no specific selection criteria for inclusion in the in-depth study, however inclusion required contact with parents and vehicle owners before vehicle repairs had taken place. This may have biased the in-depth sample towards more severe crashes, and also towards families that were easier to contact. However comparison of crash severities and injury outcomes between these two groups demonstrates that there was little inter group differences in these variables with the exception of slightly more seriously injured children (>ISS 9) in the in-depth sample. The validation study showed that data collected through case review was 100% accurate for crash direction, 85% accurate for seating position and restraint type and 64% accurate for crash severity.

Lastly, the association between restraint quality and injury outcome in terms of MAIS and ISS was adjusted for crash severity. In theory other factors such as seating position and crash orientation may have some influence on injury outcome, however in this sample these factors were not found to be potential confounders. There was no association between seating position and impact direction and injury outcome, and no significant differences in the distributions of appropriately and inappropriately restrained children by seating position or crash orientation. There were however some differences between inappropriately and incorrectly restrained children, with all children incorrectly using restraints being seated in the rear and involved in frontal impacts. Theoretically, these seating positions in frontal impacts would confer a protective effect. The lack of control for these confounders, if an issue at all, would lead to conservative estimates of any increased risk of injury due to incorrect restraint.

Acknowledgements

Parts of this work were funded by the NSW Motor Accidents Authority. Thanks also to Dr Michael Henderson, Dr Mary McCaskill, Marijke Oomens and Dr Mick Yuen for their contributions to this work; and the NSW RTA's Crashlab and Holden for the use of their child dummies.

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Research Study into the Speed Behaviour of Long and Short Haul Heavy Vehicle Drivers

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This paper was originally presented at the November 2005 Road Safety Research, Policing and Education Conference held in Wellington, New Zealand.

Abstract

In 2005, the Roads and Traffic Authority (RTA) commissioned AMR Interactive to conduct a speed knowledge, attitudes and self reported behaviour research study to identify the reasons why long and short haul heavy vehicle drivers' speed, evaluate the role of enforcement and the types of measures that would influence the drivers to keep within the speed limits.

The qualitative stage included 10 face to face interviews and the quantitative stage included a telephone survey of 376 heavy vehicle drivers.

The highest risk groups identified were younger short haul, younger long haul and older long haul heavy vehicle drivers. About one in ten drivers reported having been booked for speeding in the last 12 months and similar proportions reported that they would be willing to drive more than 10 km/h over the limit while 15% stated they failed to stay within the speed limit in built up areas.

About a quarter of drivers reported experiencing some pressure to speed to meet deadlines. Drivers reported that on-road police enforcement would have the greatest impact on their attitudes and behaviour.

Possible countermeasure strategies include development of an education strategy addressing attitudes to speeding, situational triggers, planning trips and rest breaks, encouraging companies to develop and implement anti-speeding policies and increasing visible, unavoidable police enforcement.

Introduction

Speeding continues to be a major road safety issue. In 2005 there were 70 fatal crashes involving a heavy truck, and of these 13 (19%) involved a speeding heavy truck. There were a total of 290 recorded crashes involving a speeding heavy truck - 13 were fatal crashes, 132 were injury crashes and 145 were tow away crashes. There were 171 casualties from the 290 speeding heavy truck crashes - 15 were killed and 156 were injured [1].

These figures are likely to be an underestimation of heavy vehicle speed involvement, given the high rate of speeding by heavy vehicles (see below) and the higher probability that the heavy vehicle driver will survive to tell his/her side of the story, compared with other road users.

Highway speed surveys conducted by the RTA shows that 52% of heavy vehicles were exceeding the speed limit. The survey found that a high proportion of articulated trucks (34%) and b-doubles (35%) were travelling between 1-5km/h over the limit and 13% of articulated trucks and b-doubles were travelling between 6-10km/h over the limit. Approximately 1% of articulated trucks and b-doubles were travelling 21km/h over the speed limit [2].

Method

The research study was conducted during May 2005 and consisted of a qualitative and quantitative stage. The qualitative stage included in-depth face-to-face interviews with 10 truck drivers (5 long & 5 short haul) to explore motivations/situations that lead to speeding as well as those that lead to staying within the speed limit for the development of the questionnaire for the quantitative stage.

The quantitative stage consisted of a telephone survey of 256 truck drivers and 120 face-to-face interviews with long haul drivers at a truck stop and a trucking terminal. The face-to-face interview component was included to ensure that long haul drivers were well represented in the survey. The quantitative stage examined components that influence behaviour: situational factors such as trip type, schedule, on