The characteristics of incorrect restraint use among children travelling in cars in New South Wales, Australia

Julie Brown¹, Julie Hatfield², Wei Du², Caroline F Finch³, Lynne E Bilston¹

¹Prince of Wales Medical Research Institute and University of New South Wales, Barker St, Randwick, 2031, NSW, Australia

²Injury Risk Management Research Centre, University of New South Wales, 2052, NSW, Australia

³School of Human Movement and Sport Sciences, University of Ballarat, Victoria, Australia

Julie Brown, email J.brown@powmri.edu.au

Julie Hatfield, email j.hatfield@unsw.edu.au

Wei Du, email wdu@george.org.au

Caroline Finch, email c.finch@ballarat.edu.au

Lynne Bilston, email L.bilston@powmri.edu.au

Communicating Author:

Julie Brown

Prince of Wales Medical Research Institute, UNSW,

Barker St

Randwick NSW 2031

Australia

Tel: +61-2-9399-1041

Fax: +61-2-9399-1082

Email: j.brown@powmri.edu.au

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ABSTRACT

Objective. This study aims to provide population estimates of incorrect restraint use among children aged 0-12 travelling in cars in NSW, and describe the errors occurring in different restraint types.

Methods. Observations of randomly selected children and restraints were conducted in situ by trained researchers at sites statewide. Observation sites were randomly selected using a multistage stratified sample plan. Restraint use errors were recorded and analysed by severity of error and restraint type using complex survey analysis techniques.

Results. One in two children was incorrectly restrained, and 38% in a serious manner. Multiple errors were common (31% of children). Both installation and 'securing' errors were common, with installation errors more common in convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats) than single mode restraints (OR 4.3, 95% CI 1.7-10.8). Multiple errors were more common in convertible restraints (OR 3.6, 95% CI 1.9-7.0). The most frequently observed errors were excessive seat belt slack (>25mm), incorrect belt routing, non-engagement of the seat belt buckle, very loose harness (>25mm slack), harness off the shoulder, non-use of belt guides, sash belt worn under the arm, and very twisted harnesses and belts (>2 twists). For rearward and forward facing restraints, the highest priorities in terms of frequency and degradation in crash protection are errors related to harness use. For booster seat users, the most important are those related to correct seat belt and belt guide use. For seat belt users, errors related to correct positioning of the sash belt are key.

Conclusions. The results indicate that many errors are currently occurring in the way children are using restraints, as well as problems associated with the way child restraint systems are installed in vehicles. Incorrect use is particularly problematic in convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats). Different priorities, in terms of the frequency and potential degradation in crash protection due to incorrect use for different restraint types exist, and these are important for those designing countermeasures to this problem.

INTRODUCTION

Incorrect use of a restraint reduces the effectiveness of that restraint in a crash (Bilston et al, 2007; Brown & Bilston, 2007; Du et al, 2008; Elliott et al, 2006; Lalande et al, 2003; Lesire et al, 2007), and occurs when the user does not use the restraint as it was designed to be used, i.e. when there are errors in how a restraint is installed in a vehicle and/or how a restraint is used by a child. Incorrect child restraint use has been reported to be a common occurrence among children travelling in cars in Australia, Europe and North America but most studies of this problem have relied on self-selected samples (Koppel & Charlton, 2009), crash-involved samples (Brown & Bilston 2007; Gotschall et al, 1997; Hummel et al, 1997), or convenience samples (Decina et al, 1997; Paine & Vertsonis, 2001) and hence do not provide broad population estimates of incorrect use. Moreover, most studies focus on only one or more type of child restraint and do not include children who are too big for child restraint systems and are therefore using adult seat belts.

There are many ways in which a restraint system can be used incorrectly and understanding which forms of incorrect use occur most frequently is important in prioritizing countermeasures to address incorrect use. Since different restraint types are used by children of different ages/sizes, and these restraint types vary considerably in design, we hypothesized that there are different priority population target groups for different restraint types. To prioritise the importance of error types by restraint type in a robust manner that could be used to directly inform road safety policy, the sample used should closely reflect the entire population of children using restraints, and should describe the errors occurring in detail. Furthermore, direct observations of children using different restraint systems, in addition to detailed examination of those restraint installations, is required to quantify the comparative frequency of installation errors and errors involving how the restraint is used by the child.

This study aims to provide population-referenced estimates of correct and incorrect use by restraint type among children travelling in cars in NSW, as well as a detailed description of the errors in restraint use. This information is vital for those designing restraints and other countermeasures, such as education strategies and policy responses, to ensure correct use of different restraints by all children.

METHODS

A multistage stratified, clustered random sample plan was used to collect data representing the population of children aged 0-12 years in NSW, Australia. The sample design and data collection methods have been described in detail elsewhere (Brown et al, *submitted AAP*). In brief, four strata across NSW were constructed based on geographical location, and clusters (also based on geographical area) were drawn from within each stratum. Observation sites (baby/child health clinics, preschools, day care centres and primary schools) were then randomly selected from within each cluster. Vehicles were randomly selected as they arrived at the observation sites. After gaining parental consent, children and the restraints they used, were observed within the vehicle. In vehicles where more than one child was travelling, the child who had had the most recent birthday was selected for observation. Approval for the conduct of this study was granted by the UNSW Human Research Ethics Committee, NSW Health Ethics Committees, the NSW Department of Education and Training, and the principal of each sampled school.

Data was collected by trained researchers who attended data collection sites over one to two hours corresponding with drop-off times at preschools and primary schools, and morning and afternoon sessions at early childhood health clinics. Initial observations were made with the selected child in situ and then after the child left the vehicle a detailed examination of the restraint installation was conducted. The type of restraint, the way the restraint was being used, and how the restraint was installed, were recorded based on these observations using a standardised data collection form. Details regarding the size appropriateness of the restraint were also collected and this information is reported elsewhere (Brown et al, *submitted AAP*).

Restraint use was coded as correct if the restraint was being used exactly as the manufacturer intended (excluding size-appropriateness), and incorrect if it was being used in any other manner. Each type of incorrect use was recorded, with both the type of error and the number of errors per restraint noted. Incorrect use was also coded as installation error only, 'securing' errors only, or a combination of both. Installation errors were defined as those that related to how the restraint was anchored to the vehicle, and 'securing' errors defined as those that related to how the child used the restraint and how the restraint was adjusted for use by that child. Errors were also categorized into the following error types: anchorage, gated buckle/locking clip, harness, seat belt, top tether and other; and rated as minor, or serious. Severity ratings were based on the likely threat of injury and/or the likely degradation in protection due to that error. Rating assessments were based on evidence published in laboratory studies investigating the influence of incorrect use (Hummel et al, 1997, Lalande et al, 2003; Lesire et al, 2007; Bilston et al, 2007) and crash studies demonstrating the

real world effect of incorrect use (Gotschall et al, 1997; Brown et al, 2006; Bulger et al, 2008). An attempt was also made to ensure consistency with other observational studies that have included incorrect use severity ratings (Eby and Kostyniuk, 1999; Decina and Lococa, 2005).

Restraint types were described according to restraint type definitions given in the relevant manufacturing standards AS/NZS 1754 (AS/NZS, 2004) i.e. rearward facing restraints, forward facing restraints, child safety harnesses or booster seats; and seat belts (including both lap only and lap/sash belts). In some analyses, restraints were grouped into dedicated child restraints (rearward facing restraints, forward facing restraints, child safety harnesses or booster seats) and seat belts. Restraints were also coded as 'convertible' if they were designed for use in more than one mode, i.e. restraints that can be used both rearward and forward facing, and forward facing restraints that convert to booster seats.

Data analysis

All data was entered into a custom designed data base and analysed using SAS version 9.2 (SAS Institute, 2008). Sample weights were constructed using standard weighting procedures as outlined by Lohr (1999) and Korn & Graubard (1999). Population weighted estimates of the proportion of children correctly and incorrectly using restraints by restraint type, and with and without multiple errors by restraint type, were generated using the SURVEYFREQ procedure. Population weighted estimates of the proportion of children by number of errors per restraint were also generated using the SURVEYFREQ procedure, including estimates of the variance and corresponding 95% confidence intervals (CI). This procedure was also used to conduct a sub-group analysis of the error types by restraint types. Unweighted frequencies of each type of error were also calculated, and the SURVEYFREQ procedure used to conduct a second domain analysis to calculate the population weighted estimates of the frequency with which each of the ten most common errors was observed for each restraint type. The significance of associations between multiple errors and whether or not the errors involved installation or securing errors, and convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats) were explored in two separate logistic regression models via the SAS SURVEYLOGISTIC procedure and adjusted for restraint type. Odds ratios (OR) and 95% CI were calculated, relative to a baseline or reference category for each of the independent variables (the same variables were use in each model).

RESULTS

Observations were made for 501 children aged 0-12 years. Just over half (51.4%) were incorrectly using their restraints, and 38.3% were incorrectly using their restraints in a serious manner. Figure 1 illustrates the proportion of incorrect use observed by type of restraint, demonstrating that incorrect use was more common in dedicated child restraint systems and serious incorrect use occurred in approximately equal proportions in rearward facing restraints, forward facing restraints and booster seats, as opposed to seatbelts only.

<Insert Figure 1 close to here>

Multiple errors were observed in 31.1% of children (Table 1), and were particularly common in rearward and forward facing restraints (Figure 2). Multiple (≥ 2) errors were significantly more common among convertible restraint users (rearward facing/forward facing restraints and forward facing restraints/booster seats users) than those using single mode restraints (adjusted for restraint type, OR 2.8, 95% CI 1.6-4.7).

<Insert Table 1 & Figure 2 close to here>

Installation errors were equally as common as errors in securing the child in rearward facing restraints, but 'securing' problems were more common in all other restraints (Figure 3). Installation errors were significantly more likely to be observed among convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats) than restraints designed for a single mode of use (adjusted for restraint type, OR 3.6, 95% CI 1.9-7.0), but there was no difference in frequency of 'securing' errors between these restraint types.

<Insert Figure 3 close to here>

Forms of incorrect use

A total of 653 errors of 57 distinct forms among 501 children were observed. Descriptions of these and the frequency with which each occurred in this sample are given in Table 2. Weighted estimates for the ten most frequently observed serious errors for each restraint type are given in Table 3.

<Insert Table 2 and Table 3 close to here>

The different forms of incorrect use were categorised as shown in Table 4, demonstrating that, overall, problems with the harness and the seat belt occurred most frequently, but there was some variation in their frequency depending on the type of restraint.

<Insert Table 4, close to here>

Unsurprisingly, seat belt errors were the most common securing errors in seat belt and booster seat users. Problems involving the seat belt were common installation errors in forward facing child restraints. They also occurred in rearward facing restraints but were proportionally less of a problem than installation errors involving the top tether.

For children using rearward and forward facing restraints, harness problems are the greatest concern. Child safety harnesses are used alone or in combination with booster seats, and problems associated with harness adjustment were the most common-use problem with these restraints. Among those using booster seats, approximately one quarter of errors involved belt guide features (Table 4).

DISCUSSION

The key finding of this unique, population referenced analysis is that while incorrect restraint use is widespread, important variations in the nature of incorrect use exist depending on restraint type. Multiple errors are common among children using dedicated child restraints, and most common in convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats). Installation errors also occur more frequently with the use of convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats). Overall, addressing errors in how a child is secured within the restraint is equally as important as addressing installation to optimize the protection provided to children when they travel in cars.

Incorrect use was observed to frequently involve seat belt and harness errors. The seat belt functions differently in different restraint systems. In rearward and forward facing systems, seat belt errors are installation errors. Problems with the seat belt are 'securing' errors in children using seat belts, child safety harnesses and booster seats. Harness errors are almost always 'securing' errors. In this study, securing errors accounted for the greatest proportion of incorrect use in all restraint types except rearward facing

restraints, confirming the observation made by Eby et al (1999) that ‘people have somewhat more difficulty in properly placing the child in the CSS [child safety seat] than installing the CSS in the vehicle’.

The high frequency of harness errors is consistent with the findings of other studies that have previously investigated incorrect use among rearward and forward facing child restraints (Koppel et al, 2009; Blair et al, 2008, Decina et al, 2005; Eby et al, 1999), and the high incidence of seat belt errors among booster seat users is consistent with other studies focused on that restraint (Morris et al, 2007; O’Neil et al, 2009). Unlike previously published studies, we also observed non-use of a sash guide as an almost equally frequent problem among booster seat users. This is concerning since non-use of the sash guide is likely to lead to poor positioning of the sash and a consequent reduction in protection in a crash.

All rearward and forward facing Australian child restraints are equipped with 6-point internal harness systems and require the use of a top tether. The most serious harness errors observed in these restraints were non-use or partial use of the harness. This included children sitting in the restraint and not using the harness, children with one or both arms outside the harness, and others who had the harness positioned off their shoulders. Threading of the harness straps through the wrong slot height for the child’s shoulder height sometimes contributed to the latter, with the use of a low shoulder slot causing the harness straps to come off the shoulder. Loose and very twisted harnesses (the latter resulting in the harness effectively being loose) were also common. Similar ‘securing’ problems were observed in booster seats and those using adult seat belts, with the most common serious form of incorrect use involving non-use of the shoulder belt. This occurred when the shoulder belt was placed behind the back of the child or the restraint, or under the arm. These forms of incorrect use have been demonstrated to seriously degrade the protection provided in a crash (Bilston et al, 2007; Lalande et al, 2003; Lesire et al, 2007), and appear to be more common in Australia than previously thought.

Incorrect positioning of the sash belt among booster seat users and those using seat belts might be related to discomfort and/or parental perception of the risk (real or otherwise) associated with sash belts passing close to the neck in small children. We saw more seat belt errors among children who had been prematurely graduated to booster seats (44%) than among those appropriately using booster seats (39%), and among those prematurely graduated to adult seat belts (31%) than those appropriately using belts (22%). The contribution that poor seat belt fit makes to the incorrect positioning of the belt was not tested in this study, but our observations suggest this may be an interesting area for further research.

Belt guide problems were less common in children prematurely graduated to booster seats. Seat belt problems more common in booster seat users and adult seat belt users prematurely graduated.

Both rearward facing and forward facing restraints require some effort in installing them since, in Australia currently, all of these restraints are anchored via the seat belt and the top tether. Convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats) appear to be associated with a greater potential for installation errors, and further study of the design features of convertible restraints influencing this is indicated.

It is also clear from this study that when incorrect use occurs, multiple errors are common. The full consequences of this novel finding on injury risk is unknown but should be the focus of detailed biomechanical studies. Most prior laboratory studies investigating the impact of incorrect use on crash protection have only studied the impact of single errors (Hummel et al, 1997; Lesire et al, 2007; Bilston et al, 2007). Lalande et al (2003) investigated the compounding effect of slack in both the anchorage system and harness system of forward facing restraints and found that the multiple errors amplified the degradation in crash protection of each form of incorrect use. Some forms of incorrect use thought to have little impact on injury protection in a crash might also be more serious when coupled with other forms of incorrect use. This issue is also worthy of further investigation.

Countermeasures for improving the correctness of restraint use.

Internationally, the development of methods of attaching child restraints to vehicles such as ISOFIX and LATCH, aim to reduce serious installation errors related to seat belt routing. In this study, these errors accounted for about one quarter of all errors in forward facing child restraints and 10% in rearward facing child restraints. Even if these systems were 100% successful in removing such errors, there is still a need for other countermeasures to reduce other installation errors, and securing errors.

In Australia, a restraint fitting station network has been in operation since the 1980s. These commercially operated businesses were established to assist parents and carers to correctly install and use child restraint systems. It is possible that together with the long-standing use of top tethers, and unique top tether design requirements in Australia, they may be influencing the comparatively low proportion of problems seen with the use of top tethers, (in this study $\approx 20\%$ in forward facing seats, $\approx 60\%$ in North America, (Decina and

Lococo, 2007). However, there are still substantial numbers of installation errors occurring, and scope for further attention to countermeasures to reduce these forms of incorrect use exists.

Child restraint 'ease of use' rating systems have also evolved as an advocacy tool to reduce incorrect use (Pedder, 2007; Brown et al 2007a). These programs aim to use consumer pressure to encourage the design of child restraint systems towards having a lower propensity for incorrect use. There is anecdotal evidence in North America at least, that these programs are leading manufacturers to improve some aspects of child restraint design (Pedder, 2007). However, there is clearly further need for reducing the complexity of correctly using child restraints, and field-based observational studies like this current study provide an excellent resource for the refinement and further evolution of these 'ease of use' rating systems.

Many existing countermeasures primarily target installation errors, but in this study we observed securing errors to be the greatest problem. These findings indicate a need for more stringent requirements in consumer information programs and in regulatory standards to address the propensity for incorrect use of harnesses in rearward and forward facing restraints and the seat belt in booster seats. As Rudin-Brown et al (2003) noted some feedback mechanism that alerts users (and parents/carers) to the incorrect use of harnesses would be useful. Visible and/or auditory warnings of the severity of the consequences of this form of incorrect use might also be warranted. Furthermore, this study has demonstrated that different priority areas (in terms of frequency of problem) exist for different restraint types, and this information will be useful to those designing countermeasures. For rearward and forward facing restraints the highest priority is addressing harness misuse, followed by installation problems involving the seat belt and the top tether. For booster seats, the highest priority areas involve misuse of the seat belt, and belt guide features. Similarly for seat belt users, the priority is correcting errors associated with positioning of the belt. The most common harness and seat belt errors, were excessive (>25mm) slack. Non-use and partial use of the internal harness among child restraint users and the seat belt among booster seat users were also frequently observed.

Most existing strategies to incorrect use focus on design issues. ISOFIX, and consumer information programs target the design and ease of use of restraint systems in an attempt to provide systems that are difficult to use incorrectly. The results of this study indicate these types of countermeasures need to focus not only on installation errors but must also place a high priority on securing errors. The results also indicate that education based strategies may also have a place, firstly in alerting parents to the widespread nature of the problem and, secondly, in specifically targeting behavioural-based errors such the non-use of harnesses

and the sash of the seat belt. However, the usefulness of education-based approaches needs further study, since it might be that design-based interventions, such as visual and/or audible warnings when the harness or seat belt are not used correctly is more effective than attempting to change behavior through education alone.

Limitations

The data presented here are drawn from a population-referenced sample of observations of children travelling in cars in NSW. There are a number of inherent limitations in the sampling method that might influence the estimates of incorrect use and specific forms of incorrect use. These relate to the assumption inherent in the sampling plan that there was an equal probability of all children within NSW being observed at the data collection points. Post-stratification was used to adjust sample weights to account for any population under-coverage as a means of trying to minimise any potential bias. Another potential limitation is the fact that observations were made within a single trip type, i.e. travel to day care, school etc, on weekdays only and at a single point in time. It is possible that the way children use restraints, and the way restraints are installed in vehicles varies with day of the week, time of day, trip type and also through out any particular journey. Furthermore, the vehicles carrying the children captured in this study were predominantly being driven by mothers and it is possible that incorrect use could vary depending on the relationship between the driver and the child.

CONCLUSION

This study provides a population-referenced snap shot of incorrect use of restraints of children aged 0-12 years travelling in cars in NSW and provides a detailed description of the characteristics of incorrect restraint use by restraint type. The results indicate that overall there are many errors currently occurring in the way children are secured in or using restraints, as well as problems associated with the way dedicated child restraint systems are installed in vehicles. When incorrect restraint occurs, multiple errors are common. Children using convertible restraints (rearward facing/forward facing restraints and forward facing restraints/booster seats) are more likely to have multiple errors, and errors involving the installation of the restraints, than children using restraints designed for a single mode of use. The highest priority for reducing incorrect use lies in addressing incorrect use of the harness in rearward and forward facing restraints; incorrect use of the seat belt, and belt guide features in booster seats; and incorrect positioning of the sash belt behind the back or under the arm among those using seat belts alone.

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Figures

Figure 1: Incorrect use by restraint type as a percentage of children using these restraint types. (RF – Rear facing child restraint, FF- Forward facing child restraint, CSH – Child safety harness).

Figure 2: Number of errors by restraint type as a percentage of children using these restraint types. (RF – Rear facing child restraint, FF- Forward facing child restraint, CSH – Child safety harness).

Figure 3: Type of error by restraint type as a percentage of children using these restraint types. Minor forms of incorrect use excluded. (RF – Rear facing child restraint, FF- Forward facing child restraint, CSH – Child safety harness).

Tables

<i>Number of errors</i>	<i>Weighted Estimates</i>	
	<i>Estimate</i>	<i>95% Confidence interval</i>
0	48.6%	40.7 – 56.6%
1	20.3%	13.2 – 27.3%
2	16.3%	12.2– 20.3%
3	7.6%	4.7 – 10.5%
4	5.2%	2.5 – 7.9%
5	1.4%	0.0 – 2.9%
6	0.5%	0.0 – 1.4%
7	0.1%	0.0 – 0.2%
Total	100%	

Table 1: Distribution of the number of restraint use errors in observed children (95% CI, truncated at 0)

<i>Description (Serious errors)</i>	<i>% of errors</i>
Anchorage point problem - top tether attached to luggage tie down	0.8
Anchorage point problem -tether anchor bolt loose	0.2
Anchorage point problem -top tether anchored to wrong position	0.2
Belt guide problem - sash guide not being used	4.0
Belt guide problem - incorrectly positioned sash guide leading to poor belt position	1.1
Belt guide problem - lap belt guides not correctly used	0.5
Belt guide problem - anti-submarine clip not used not used	0.3
Belt guide problem - sash guide on adjacent restraint used	0.2
Gated buckle/Locking clip problem - no gated buckle used with lap sash & harness	0.8
Gated buckle/Locking clip problem -gated buckle not adjusted correctly	0.8
Harness problem - harness very loose	4.1
Harness problem - harness very twisted (>2 twists)	2.8
Harness problem - internal harness shoulder height low and effectively off shoulder	2.1
Harness problem - arms partially out of harness	1.5
Harness problem - internal harness not used	1.1
Harness problem - safety harness overtightened	0.8
Harness problem - internal harness too high	0.6
Harness problem - harness height low but on shoulders	0.3
Harness problem - arms completely out of harness	0.2
Harness problem - incompatible harness used with booster	0.2
Harness problem - internal harness not threaded through body of seat	0.2
Seat belt problem - seat belt slack >25mm	9.5
Seat belt problem - belt not routed correctly	3.8
Seat belt problem - shoulder belt worn under arm	2.8
Seat belt problem - webbing very twisted (>2 twists)	2.1
Seat belt problem - not engaged	1.8
Seat belt problem - shoulder belt worn behind back	1.2
Seat belt problem - shoulder belt not used	0.6
Seat belt problem - shoulder belt worn across arm	0.5
Seat belt problem - defective seat belt	0.2
Top tether problem - slack >25mm	1.1
Top tether problem - very twisted (>2 twists)	0.9
Top tether problem - top tether not used on RF/FF	0.8
Top tether problem - top tether incorrectly positioned	0.3
Top tether problem - top tether has been unbuckled and rethreaded incorrectly	0.2
Top tether problem -problem with attachment to restraint	0.2
Top tether problem - not run through guide & frayed needing replacement	0.2
Other problem - Non - AS approved restraint	0.6
Other problem - stabiliser bar not used	0.6
Other problem -bag/back pack worn on back	0.5
Other problem - CRS installed with base against back seat	0.2
Other problem - buckle used incorrectly	0.2
Other problem -using armrest as booster	0.2

<i>Description (Minor errors)</i>	<i>% of errors</i>
Anchorage problem - anchor point plug on back shelf loose & safety clip on hook missing	0.2
Gated buckle/Locking clip problem - seat belt lock on side of CRS not used	0.3
Gated buckle/locking clip problem - seat belt locker used on both sides of seat	0.2
Harness problem - harness mildly twisted (≤ 2 twists)	12.7
Harness problem - harness slightly loose ($\leq 25\text{mm}$)	11.5
Harness problem - in low slots with little effect	5.2
Harness problem -internal harness keeper not engaged /out of place	2.5
Seat belt problem - webbing mildly twisted (≤ 2 twists)	9.7
Seat belt problem - belt routed incorrectly and fouling harness	2.0
Top tether problem - slack in top tether ($\leq 25\text{mm}$)	3.1
Top tether problem - top tether not used on booster	0.3
Other problem -baby insert still in place	1.7
Other problem - stabiliser bar still in use	0.2
Other problem - extra cushion in restraint	0.2
TOTAL	100%

Table 2: Types of errors observed, categorized by severity of error (unweighted and expressed as percentage of total errors observed).Total number of errors = 653.

	<i>Weighted Estimates – RF & FF</i>		<i>Weighted Estimates – Booster</i>		<i>Weighted Estimates – Harness</i>		<i>Weighted Estimates – Seat belt</i>	
	<i>Estimate</i>	<i>95% CI</i>	<i>Estimate</i>	<i>95% CI</i>	<i>Estimate</i>	<i>95% CI</i>	<i>Estimate</i>	<i>95% CI</i>
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Seatbelt slack >25mm	10.6	2.5-18.6	16.3	6.9-25.8	-	-	11.9	1.4- 22.5
Harness very loose	7.8	3.0-12.6	2.7	0.0- 6.2	15.7	0.0- 61.5	-	-
Sash guide not used	-	-	17.5	9.8-25.2	-	-	-	-
Seat belt not routed correctly	8.8	3.5-14.2	0.2	0.0- 0.8	-	-	-	-
Sash worn under arm	0.5	0.0-1.7	8.5	0.0-22.6	-	-	3.3	0.2-6.4
Harness very twisted	8.8	3.6-14.0	0.2	0.1- 0.3	-	-	-	-
Seat belt very twisted	3.1	0.0- 7.2	2.7	0.0-8.0	-	-	3.5	0.0- 7.2
Harness low and off shoulder	5.0	1.3- 8.6	-	-	-	-	-	-
Seat belt not engaged	7.8	3.2-12.4	-	-	-	-	-	-

Table 3: Prevalence of the 10 most frequent serious errors among children using different restraint types

Restraint Type	Misuse category	% Estimate (95% CI)
RF Restraint	Anchorage	5.9 (0.0-20.2)
	Gated buckle/locking clip	2.4 (0.0-8.7)
	Harness	52.0 (28.3-75.8)
	Other	11.4 (0.0-29.8)
	Seat belt	38.8 (12.5-65.1)
	Top tether	15.9 (8.3-23.5)
FF Restraint	Anchorage	4.4 (0.3-8.5)
	Gated buckle/locking clip	6.5 (0.0-20.2)
	Harness	55.8 (45.3-66.3)
	Other	10.4 (2.7-18.0)
	Seat belt	36.5 (28.2-44.3)
	Top tether	16.7 (8.0-25.4)
Booster	Belt guide	33.12 (22.2-44.0)
	Gated buckle/locking clip	5.7 (0.0-15.8)
	Harness*	10.0 (0.0-20.8)
	Other	1.5 (0.0-5.4)
	Seat belt	38.1 (27.5-48.6)
	Top tether	0.6 (0.0-2.3)
CSH	Gated buckle/locking clip	84.3 (38.4-100.0)
	Seat belt	15.7 (0.0-61.5)
Seatbelt	Other	1.7(0.0-4.9)
	Seat belt	19.9 (7.4-32.5)

Table 4: Prevalence of forms of restraint errors among children using different restraint types. * some children used accessory child safety harnesses with booster seats . (RF – Rear facing child restraint, FF- Forward facing child restraint, CSH – Child safety harness).