Alberta Occupant Restraint Program (AORP): Report of the Alberta Child Restraint Evaluation Study

Prepared by the Alberta Health Services
Injury Prevention Program
on behalf of AORP
January 2010

Acknowledgements

The Alberta Child Restraint Evaluation Study (ACRES) has been an enormous undertaking that would not have been possible without the contribution of many people. The Provincial Steering Committee of the Alberta Occupant Restraint Program (AORP) would like to acknowledge the generous contributions of the following organizations and individuals.

- The Stollery Children's Hospital Foundation
- Regional Health Authorities (2009)
- The Provincial Injury Team, Alberta Health Services
- Lacey Hoyland – Alberta Health Services
- Dr. Don Voaklander – Alberta Centre for Injury Control & Research
- Dr. Brent Hagel – Calgary Children's Hospital
- Richard Golonka – Alberta Health Services
- AORP Research Sub-Committee

Table of Contents

Executive Summary

Motor vehicle collisions are the leading cause of death and serious injury for Canadian children. Safe Kids Canada (2004a; 2004b) estimates that 68 children under the age of 14 are killed every year in motor vehicle crashes and another 800 children are seriously injured.

Alberta law currently requires that children under the age of 6 years and weighing less than 40 lbs (18 kg) be secured in an appropriate child restraint. There is a compelling body of evidence that suggests children should travel in an age and weight appropriate child restraint until they are 9 years old or 80 lbs (36 kg). Booster seats are a recommended progression from a forward facing child restraint because they raise a child up so that the seatbelt crosses the child's body at the intended points. Seven provinces in Canada have recognized the importance of booster seats and have implemented booster seat legislation. There is no booster seat legislation in Alberta.

As part of the Alberta Traffic Safety Plan and National Road Safety Vision 2010, the Alberta government has committed to increasing proper child restraint use and decreasing the number of motor vehicle related injuries to children. This study was designed to identify the prevalence of correct and incorrect motor vehicle restraint use for children under nine years old in Alberta. The results are intended to improve the amount and quality of information regarding child restraint use available to the Alberta government and other stakeholders.

Schools and daycares were randomly selected from across the province in the summer of 2008. This cross sectional study included a combination of driver interviews and observation of child restraints. The study was not without its limitations; how generalizable the results are to Alberta children under 9 years cannot be determined without confirmation of how closely the sample matches the intended sampling plan. In light of these considerations, the results must be interpreted with caution. While it is difficult to know if the conclusions can be applied to all Alberta children under 9 years, they are consistent with the research in the area. Within this context, the results are actionable, that is, they have implications for increasing proper child restraint use and decreasing the number of motor vehicle related injuries in children.

Study Findings

Of the drivers approached, 79% (n=920) agreed to participate, 41% from rural and 59% from urban areas of the province. The majority of drivers (84%) were approached at daycares; the remaining 16% were approached at schools or day camps. Day camps were used as a substitute for schools where school boards did not grant permission for their schools to be used as study sites. There were a total of 1,135 children with complete data and whose weight based on their age fell between the 1st and 99th percentile on the WHO (2009) growth charts.

The majority of the drivers in this study were mothers in their twenties or thirties who were picking up their children. Almost all of the drivers, where an observation could be made, were properly restrained. Generally, there were between one and two children in the vehicle. Most drivers had commutes of 20 minutes or less and did not travel at highway speed while commuting. Children spent less than 3 hours per week in the car outside of the daily commute.

Categories of Seat Use

Three categories of seat use were analyzed in the report based on the classification of minor and major misuses identified by the study. Seat use was considered completely correct if there were no misuses in installation or use; functionally correct if there were misuses identified as having the potential for minor injury but not life threatening injury during a collision; or catastrophic if

there were errors (misuse) in the child restraint use or installation identified as having the potential for life threatening injury during a collision.

Seat Choice and Seat Use

Seat belts, based on current Alberta legislation, were the legally correct choice for the majority of children observed in them. But best practice, based on research that takes into account age and weight, suggests that only a minority of the children in seat belts were in the correct choice.

Alarmingly, there was at least one catastrophic use observed for almost all of the children in seat belts. This result is consistent with previous studies that suggest high rates of premature graduation to adult seat belts. Catastrophic uses observed were related to the fit of the belt across the hips and the chest, suggesting that the children may have been more appropriately restrained in a booster seat.

The majority of children observed to be riding in booster seats, forward facing and rear facing seats were in the appropriate child restraint based on both legislation and best practice. Some catastrophic use was observed, particularly with forward facing seats. The subjective experience of drivers in this study suggests that tether straps may be difficult to use, and that there may be some confusion between tether straps and the UAS system.

A loose shoulder harness was a catastrophic use that was observed in both forward facing and rear facing child restraints. Drivers reported that harnesses were sometimes difficult to use, and that children's clothing also made it difficult to use correctly. Driver responses also reflected that they did not always recognize that a tight harness was important. Although catastrophic use with booster seats was rare, in a handful of cases it was observed that the shoulder belt did not cross the child's chest, suggesting that the child may have been too short for a booster.

Determinants of Catastrophic Use

Unlike previous research, there were no specific determinants of catastrophic use identified. Driver seat belt use, the amount of travel per week with children, the speed of travel, and whether or not drivers had consulted with a health professional did not appear to differ based on the identification of catastrophic use. Driver gender, age and relationship to the child being transported also did not differ.

Barriers to Correct Use

Knowledge of age and weight guidelines for graduation from one type of child restraint to another was not a barrier to correct use. Potential barriers reported by drivers, regardless of whether there was catastrophic use observed, included a lack of awareness of their own misuse, the child's behaviour, and the fit of the seat with winter clothing.

Implications of the Results

While the results must be interpreted with caution, they can be used to formulate strategies to increase proper use and decrease the number of motor vehicle related injuries to children.

Children in Booster Seats

The results suggest that increasing booster seat use would better protect children who have outgrown forward facing child restraints. The importance of height as an aspect of fit and correct use were also highlighted. Booster seat legislation has been shown to increase booster

seat use (Farmer, Howard, Rothman & MacPherson, 2009; Snowdon et al., 2009). Research suggests that booster seat legislation should be supplemented by education and awareness campaigns (Koppel, Charlton, Fitzharris, Congiu, & Fildes, 2008).

Implications for Action

- Pursue definitive booster seat legislation in Alberta.
- Supplement this booster seat legislation with education and awareness campaign to help parents understand correct use and fit of booster seats. Include height, weight, as well as age in education and awareness campaign materials, in addition to information about the new law.

Children in Rear and Forward Facing Seats

The results suggest that the combination of legislation and educational efforts with parents of children in rear and forward facing seats have been effective in protecting children under 40 lbs (18 kg). Parents are, for the most part, knowledgeable about child restraints and how to use them correctly, and access information about child restraints from a variety of sources. Parents knew the correct seat choice for their children and showed relatively low levels of catastrophic use.

Implications for Action

- Target educational efforts on those aspects of fit that, if incorrect, will be catastrophic or life-threatening in a collision. Parents of young children receive many messages regarding safe use of child restraints and about keeping their children safe in a variety of other situations. The volume of these safety messages can be overwhelming. Educational messages need to be strategic and must target the areas that are most critical. Child restraint messages need to focus on the misuses that would most likely be catastrophic or life threatening in a collision.
- It is also necessary to support professionals who work with parents to adopt this targeted approach so that parents are consistently receiving the critical messages as a priority.
- Based on the results of this study, targeted education efforts should focus on:
    - Tether straps for forward facing child restraints – include the importance of the tether strap, how it differs from UAS, and that tether straps are mandatory; and
    - Tight shoulder harness – include the importance of ensuring the harness is snug, and tips for tightening the shoulder harness.

Areas for Additional Research

- Continued surveillance of correct child restraint use at a variety of locations beyond schools and daycares to ensure that the diversity of Albertans is represented.
- Evaluation of strategies to increase correct child restraint use.
- Further identification of barriers to correct use including the range of Albertans and methods to overcome these barriers.

Alberta Occupant Restraint Program: Report of the Alberta Child Restraint Evaluation Study (ACRES)

Background

Motor vehicle collisions are the leading cause of death and serious injury for Canadian children. Safe Kids Canada (2004a; 2004b) estimates that 68 children under the age of 14 are killed every year in motor vehicle crashes and another 800 children are seriously injured. In 2005, motor vehicle collisions were identified as the leading cause of injury death for children 5 to 9 years and the second leading cause of injury death for children 4 years and under. The rate of motor vehicle traffic deaths for children and youth during the same period occurred on a magnitude almost 6 times greater than any other unintentional injury group (Public Health Agency of Canada, 2009).Yet child restraints, if used correctly, can reduce death among infants by approximately 70% and death of small children by between 54% and 80% (Zaza, Sleet, Thompson, Sosin, & Bolen 2001)**.** Correct use requires that the child restraint is appropriate for the child's age, height and weight, is installed correctly and is used correctly every time the child is transported. Booster seats provide 59% better protection than seat belts alone for children who have outgrown the height and weight restrictions of their child restraints but are still too small for a seatbelt (Durbin, Elliot, & Winston 2003).

All jurisdictions in Canada have passed legislation requiring the use of child restraints in motor vehicles; however, the restraint laws vary from province to province. There is evidence that suggests child restraint laws, including booster seat laws, increase child restraint use and reduce fatal and non-fatal injuries to children (Winston, Kallan, Elliot, Dawei, & Durbin, 2007; Gunn, Phillipppi, & Cooper, 2007; Zaza et al., 2001). A number of states and provinces have adopted legislation that requires older children to ride in booster seats and have had the opportunity to evaluate the impact of the legislation. Increases of booster seat use after legislation was implemented have been between 5% and 53% (Decina, Temple, & Dorer, 1994; Ebel, Koepsall, Bennett, & Rivara, 2003; Gunn et al., 2007; Winston et al., 2007). Gunn et al. (2007) studied booster seat use before and after legislation came into place and found that there was a significant increase in the proportion of children between 4 and 8 who were appropriately restrained after the booster seat legislation came into effect.

Alberta law currently requires that children under the age of 6 years and weighing less than 40 lbs (18 kg) be secured in an appropriate child restraint. By law in Alberta, children over 6 years must be secured with an adult seat belt. There is no booster seat legislation in Alberta. Yet, there is a compelling body of evidence that suggests children should travel in an age and weight appropriate child restraint until they are 9 years old or 80 lbs (36 kg). Children under the age of 9 or between 40 and 80 lbs (18 - 36 kg) are too small for the vehicle seat belt. Seat belts are designed to cross the adult body at the strongest points, the bones, and should sit low on the hips and cross over the chest. Without a booster seat, a child that is under 9 years old or under 80 lbs (36 kg) using a vehicle passenger restraint can bend around or slide beneath the seat belt and increase the risk of intra abdominal injury and spinal cord injury (Arbogast, et al., 2007; Durbin, Arbogast & Moll, 2001; Durbin, et al., 2003; Elliot, Kallan, Durbin, & Winston, 2006; Lutz, et al., 2003; Winston & Durbin, 1999). Booster seats are a recommended progression from a forward facing child restraint because they raise a child up so that the seatbelt crosses the child's body at the strongest and intended points.

Seven provinces in Canada have recognized the importance of booster seats and have implemented booster seat legislation. There is no law requiring booster seat use in Alberta but, as part of the Alberta Traffic Safety Plan and National Road Safety Vision 2010, the Alberta government has committed to increasing proper child restraint use and decreasing the number of motor vehicle related injuries to children by promoting the use of booster seats.

Study Rationale

ACRES was designed to identify the prevalence of correct and incorrect motor vehicle restraint use for children under nine years old in Alberta. The results of this study were intended to improve the amount and quality of information regarding child restraint use available to the Alberta government and other stakeholders.

Study Design

The study design was cross sectional and the sampling plan consisted of randomly selecting urban (>25,000 people) and rural (<25,000 people) schools and daycares from within the former health regions. The site selection was meant to be proportional to the number of eligible students enrolled in that site. Daycare locations were included to capture children under the age of 5 who are eligible for a forward or rear facing child restraint. School locations were chosen to capture children between the ages of 6 and 8 eligible for a booster seat or seat belt.

Data were collected provincially in the summer of 2008 and included a combination of driver interviews and observation of child restraints. Drivers picking up children under 9 years were approached by a team at the selected sites were approached by two research assistants. If drivers consented, one research assistant surveyed them about their child restraint practices, and the other conducted a brief visual inspection of the child restraint. The inspection identified the prevalence of proper child restraint use. The interview with drivers collected demographic information, barriers to use, sources of information about child restraints, and knowledge of child restraint laws. The interview also provided an opportunity for drivers to comment on the improper use that was observed and to report common frustrations about child restraint use (see Appendix A for the driver and child data collection forms).

Study Limitations

In applied research studies, there are often differences between the planned and actual methodology, particularly when the study is conducted at multiple sites. It is important to determine the impact of these differences on the interpretation of the results. Information about differences between the planned and actual methodology are obtained by documenting how the study was conducted at each site and what, if any, departures from the original study plan occurred.

Due to circumstances beyond AORP's control, the differences between the intended study design and implementation of that design at the various study sites is not available. In particular, information is lacking on factors affecting participation by the geographical location, site type (daycare or school) or specific site location, any action that was taken to address these factors, and the impact on the study.

Without confirmation about how closely the study sample matches the intended sampling plan, it is not clear how representative the study sample is of Alberta schools *and* daycares in both rural and urban settings. Any conclusions based on this set of results therefore cannot be generalized beyond the study sample itself.

Not all child restraints have the same weight specifications. A limitation of the study is that the weight specification of the restraint type was not recorded, only whether it was of a particular type (e.g., rear facing or forward facing). This means that it was not possible to confirm that the children were traveling in a child restraint approved for their weight. In addition, the child's weight obtained during the driver interview may only be an estimation.

Another limitation of the study design is that drivers were approached before their children were in the vehicle. If they agreed to participate, the research assistants observed drivers use of the child restraint. While there was to be minimal interaction with drivers until the children had been restrained, there is a possibility that drivers changed how they restrained their children because they were being watched. This social desirability bias could potentially affect the responses to the driver interview.

It is within these limitations that the results are analyzed and interpretations are presented. It must be emphasized that the conclusions are limited to the study sample and cannot be generalized to populations beyond the study sample.

Study Findings

The Sample

There were two samples: driver and child. The driver data were collected through the interview and the child data were primarily collected through the child restraint inspection, although some child information was obtained through the driver interview. In addition to quantitative information gathered through driver interview, qualitative information was also obtained through open-ended interview questions. Driver responses were analyzed for common themes but this analysis was limited because the observations of research assistants were not consistently separated from driver responses. All analyses of the driver data were descriptive and were intended to provide the context for understanding restraint use. The focus of analysis for child data was on child restraint use.

Not all of the drivers approached to participate consented to do so. There were 1,163 drivers approached at daycares and schools across the province. Of these, 79% (n=920) agreed to participate, 41% from rural and 59% from urban areas of the province. The majority of drivers (84%) were approached at daycares; the remaining 16% were approached at schools or day camps. In some of the former health regions, day camps were used as a substitute for schools because school boards did not grant permission for their schools to be used as study sites.

There were a total of 1,704 children in all vehicles approached. Of these, 1,364 children were observed in the vehicles of consenting drivers. Data were included only if restraint type, age and weight were known. Age and weight were then used to determine outliers based on the World Health Organization (WHO) growth charts (WHO, 2009). There were 1,345 children whose

restraint type was known. Of these, 1,135 children whose weight based on their age fell between the 1st and the 99th percentile on the WHO (2009) growth charts were further analyzed. Appendix B provides an overview of the steps used to arrive at the final sample.

The Drivers

- Almost three quarters of the drivers were female (73%) and four out of five were in their twenties or thirties (80%).
- Cars, SUVs and minivans are the most common vehicles.
- The majority of drivers were observed to be properly restrained (71%), but proper restraint could not be determined for more than a quarter (27%) of the sample. Only 2% of the drivers were observed to be unrestrained.
- Most of the cars observed (82%) had one or two children as passengers.
- Almost all of the drivers in this study (86%) were parents of children in the vehicle.
- Most drivers interviewed (89%) had commutes of 20 minutes or less.
- About a quarter (28%) traveled at highway speed during their commute.
- Two thirds of drivers (67%) reported that the children they transported spent less than 3 hours per week in the car, outside of the daily commute.

Child Restraint Use

Child restraint use was analyzed by seat choice (was the seat used appropriate for the child's weight and age) and seat use (was the seat used in a manner which would ensure the child's safety).

Correct Seat Choice

Correct seat choice was determined using current Alberta legislation for child restraints. However, in order to provide a broader context for understanding how additional child restraint legislation would improve the protection of children riding in motor vehicles, legislation and best practice were compared as a basis for determining correct seat choice (see Table 1).

Table 1: Seat Choice Criteria: Legislation and Best Practice

Seat Choice[1]	**Legislation** [2]	**Best Practice**[3]
Rear Facing	5 lbs to 35 lbs	Birth to 12 months & 5 to 35 lbs
Forward Facing	20 lbs to 40 lbs	1 to 6 years & 20 to 65 lbs
Booster	No legislation[4]	4 to 8 years & 40-80 lbs
Seat Belt	Over 40 lbs or over 6 years	9+ years & over 80 lbs

[1] The correct seat choice is also dependent on the manufacturer specifications for the seat. Because the specifications of particular seat types overlap, categories in the analyses were created to acknowledge this overlap. For example, depending on the seat, the correct seat choice for a 22 lb child could be rear facing or forward facing; based on best practice, a 42 lb child could be correct if in a forward facing or booster seat.

[2] According to the Alberta Traffic Safety Act, children under 6 years of age and under 40 lbs. must travel in child restraint that complies with the Canadian Motor Vehicle Safety Standards (CMVSS). Based on these standards, each type of child restraint approved in Canada must meet the minimum and maximum weight specifications of the seat manufacturer.

[3] Best practice criteria are based on the evidence that suggests that age and weight are factors for determining seat choice and that children should not be graduated to a seat belt until they 9 years old or 80 lbs (36 kg). These criteria also acknowledge the availability of seats that vary in weight range.

[4] There is currently no Alberta legislation that governs the use of booster seats. Booster seats, if observed, were considered a correct choice as long as the child was over 40 lbs (18 kg) and was no longer required to be in a forward facing restraint.

The child restraints observed, and whether they were the correct choice for the child according to legislation and best practice, are presented in Table 2. The majority of children observed were restrained in forward facing or booster seats.

Table 2 Observed Seat Choice: Overview of Legislation and Best Practice

	Restraint Types Observed		Correct Choice by:			
			Legislation		Best Practice	
Restraint Type	N	%	N Correct	% Observed Seats	N Correct	% Observed Seats
Seat belts	123	10.8%	113	91.9%	12	9.8%
Booster seat	440	38.8%	390	88.6%	390	88.6%
Forward facing	518	45.6%	476	91.9%	506	97.7%
Rear facing	51	4.5%	49	96.1%	49	96.1%
Unrestrained[1]	3	0.3%	0	0.0%	0	0.0%
Total	1,135	100%	1,028		957	

[1] These children were excluded from further analysis.

The majority of children in booster seats, forward facing and rear facing seats were in the correct type of restraint (seat choice) based on both legislation and best practice. There is an overwhelming difference for children in seat belts. According to legislation, almost all of these children were restrained in the correct choice based on the child's age and weight. But, according to best practice, seatbelts were the correct choice for only a small proportion of children observed to be riding in them. This large difference suggests legislation does not appear to be consistent with the current research and may be putting children at risk for injury.

Seat Use

Correct use requires not only that the child restraint is appropriate for the child's age and weight based on current legislation but that it is installed and used correctly every time the child is transported. Three categories of seat use were determined in this report based on the classification of minor and major misuses identified by the study. Seat use was considered:

completely correct if there were no misuses in installation or use;

functionally correct if there were misuses identified as having the potential for minor injury but not life threatening injury during a collision; or

catastrophic if there were errors (misuse) in the child restraint use or installation identified as having the potential for life threatening injury during a collision.

Table 3 presents catastrophic and functionally correct aspects of seat use for each type of child restraint observed in the study.

Table 3: Catastrophic and Functionally Correct Use by Seat Type

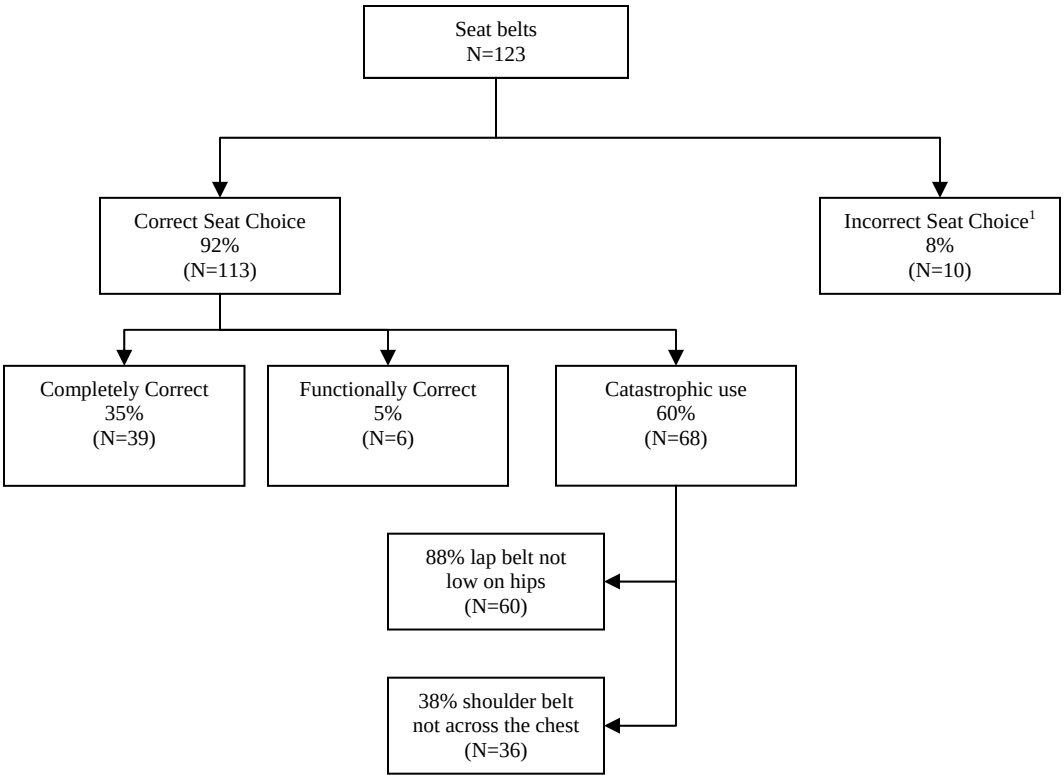
Child Restraint	Functionally Correct (minor misuse)	Catastrophic (major misuse)
Seat belt or Booster	- Seatbelt not tight	- Shoulder belt not across chest - Lap belt not low on hips
Forward facing or Rear facing	- Shoulder harness height incorrect - Chest clip not at right level - Seatbelt or UAS routed incorrectly	- Harness not snug - Seatbelt or universal anchorage system (UAS) not used - Seat facing the wrong direction - Not using tether anchor (forward facing only)

The proportion and type of catastrophic seat use was examined for children observed to be riding in seat belts, boosters, forward facing and rear facing seats. For each seat type, it is possible that more than one catastrophic use per child was observed.

Children Riding in Seat belts

Although seat belts were the correct choice according to legislation for almost all of the children observed to be restrained in them, catastrophic use of the seat belt was observed for almost two thirds (60%) of these children (see Table 4). Seat belts are intended to have the lap belt lie flat over the hips and pelvis. The most common catastrophic use (88%) was that the lap belt positioning was incorrect (not low on hips). A booster seat raises a child up so that the seat belt crosses the body at the strongest and intended points (hips and chest). It is possible that if these children were in a booster, the lap belt might be positioned more correctly over the hips. The other catastrophic use observed was that the shoulder belt did not cross the child's chest which also suggests that the upper torso would not have been restrained in a collision and that the may have been better protected in a booster seat.

Table 4: Seat belt Use Defined by Legislation

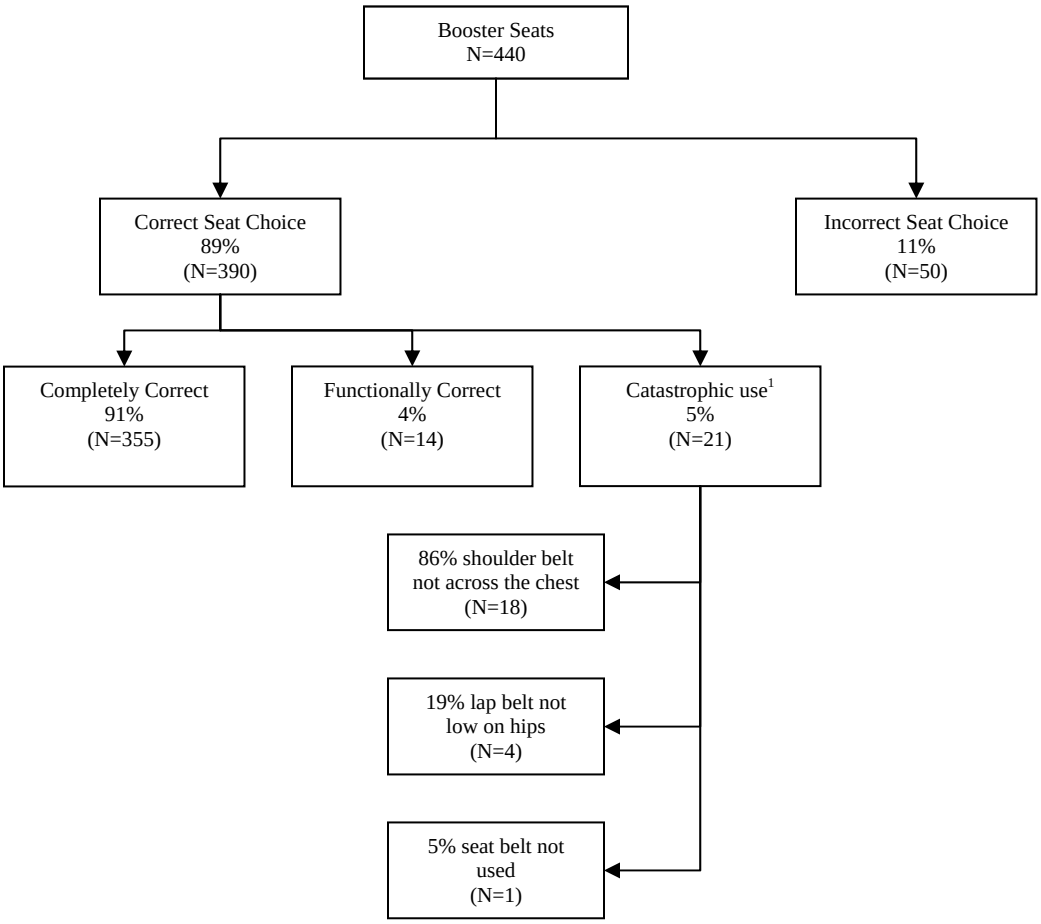


[1]More than one type of catastrophic use per child was observed.

Children Riding in Booster Seats

Booster seats were the correct choice for most of the children observed to be riding in them and were also used correctly most of the time. Catastrophic use was recorded in only a small proportion of the cases observed (see Table 5). The most common catastrophic use was that the shoulder belt did not cross the child's chest. A possible explanation for this catastrophic use could be that the child meets the weight or age recommendations to be in a booster but is not tall enough that the seatbelt crosses at the child's chest.

Table 5: Booster Seat Use Defined by Best Practice

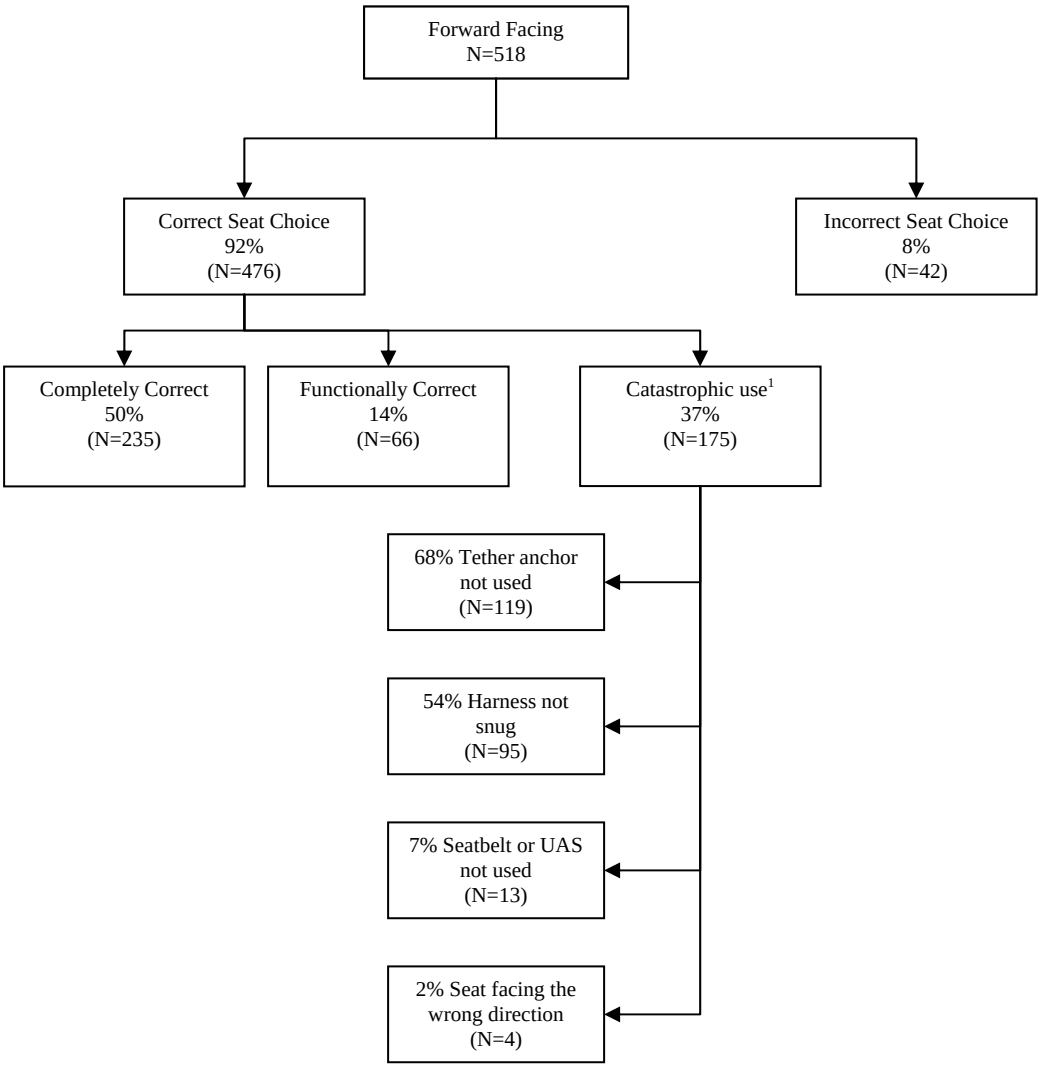


[1]More than one type of catastrophic use per child was observed.

Children Riding in Forward Facing Restraints

Most of the forward facing child restraints observed were the correct choice for the child's age and weight. Catastrophic use was recorded for just over a third of the children restrained in the correct seat choice (see Table 6). The most common catastrophic uses were that the tether anchor was not used and the harness was not snug. There appeared to be confusion around Universal Anchorage System (UAS) and tether straps as indicated in driver reports of frustrations with child restraints (e.g., drivers using UAS *and* seat belts but no tether).

Table 6: Forward Facing Restraint Use Defined by Legislation

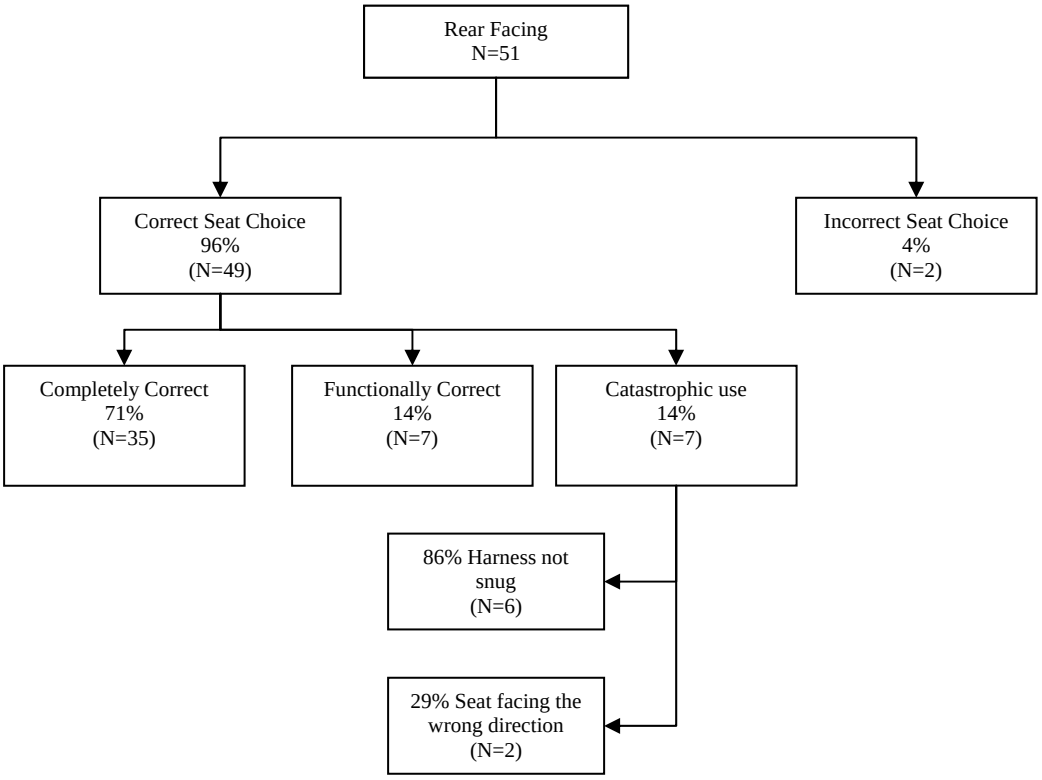


[1]More than one type of catastrophic use per child was observed.

Children Riding in Rear Facing Restraints

Most of the children observed in rear facing restraints were in the correct seat for their age and weight (see Table 7). Almost three quarters (71%) of the children observed in rear facing child restraint were completely correct; and another 14% were functionally correct. Where observed, the most common catastrophic use (86%) observed was that the harness was not snug.

Table 7: Rear facing Child Restraint Use Defined by Legislation



[1]More than one type of catastrophic use per child was observed.

Understanding Factors Determining Child Restraint Use

In order to increase correct use of child restraints, it is important to understand factors that may determine catastrophic use as well as to identify barriers to correct use.

Determinants of Catastrophic Use

Based on the driver interviews, no specific determinants of catastrophic use were identified. Driver seat belt use, the amount of travel per week with children, the speed of travel, and whether or not drivers had consulted with a health professional did not appear to differ between catastrophic use and correct use.

Drivers in this study, regardless of how they used child restraints, got information about child restraints from a variety of sources, typically between one and three different sources. Almost half the drivers (41%) had consulted with health professionals for information about child restraints and 40% also considered the child restraint manual a valuable resource. Drivers felt

that parents *should* get children restraint information from health professionals (doctors, or public health nurses) and manuals (both child restraint and vehicle). Other less common suggestions included health sites (hospitals, public health clinics or health regions), EMS (police, fire fighter, paramedic, and child restraint check stops), online, or child centre facilities (daycares and schools).

Gender, age and relationship to the child being transported also did not differ between drivers with and without catastrophic use. Other potential determinants of catastrophic use not addressed in this study include socioeconomic status and the level of child restraint enforcement in the area.

Barriers to Correct Use

Lack of parental knowledge, ease of seat use and other reported frustrations with child restraints have been identified as barriers to correct child restraint use in the past. Over three quarters of drivers in this study (77%) were aware of Alberta's child restraint misuse fine. Drivers also appeared to be knowledgeable about age and weight guidelines as they apply to child restraints. Just over half (58%) knew the rear facing to forward facing guidelines; 61% were aware of the forward facing to booster guidelines, and 53% were aware of the booster seat to seat belt guidelines.

Knowledge of age and weight guidelines was not related to catastrophic use, but more drivers were aware of these guidelines for the seats that pertained specifically to their children. Of the drivers with children in rear facing seats, 73% knew rear to forward facing guidelines. Of the drivers of children in forward facing seats, 67% were aware of the forward facing to booster guidelines. 66% of the drivers of children in booster seats were aware of the booster to seat belt guidelines.

Drivers were asked to comment on the types of misuses (both catastrophic and functionally correct) that were observed. There does not appear to be any difference in the nature of the comments for those drivers with or without a catastrophic use. The most common response was that drivers were not aware they had made an error. Other common responses included some type of justification for the misuse, including the child's behaviour (e.g., the child didn't want to keep the restraint on or that the child had buckled themselves in), that winter clothing prevented a proper fit, that someone else (e.g., a spouse) usually took care of child restraints, or that the driver was not in their usual vehicle.

Drivers also discussed common problems or frustrations that they had regarding the use of child restraints. Problems reported by drivers included difficulties in the use and installation, like straps twisting, moving the child restraint from one vehicle to another, and the size of the seat. Drivers reported frustrations with their children's behaviour as it affected restraint use. Access to information about restraint use, recalls, guidelines and regulations was other frustration identified by drivers.

Summary and Implications

This cross-sectional study was designed to identify the prevalence of correct and incorrect motor vehicle restraint use for children under 9 years old in Alberta. The study was not without its limitations and how generalizable the results are to Alberta children under 9 years cannot be determined without confirmation of how closely the sample matches the intended sampling plan. In light of these considerations, the results must be interpreted with caution. While it is difficult to know if the conclusions can be applied to all Alberta children under 9 years, they are consistent with the research in the area. Within this context, the results are actionable, that is, they have implications for increasing proper child restraint use and decreasing the number of motor vehicle related injuries in children.

The majority of the drivers in this study were mothers in their twenties or thirties who were picking up their children at daycares in both rural and urban areas of the province. Almost all of the drivers, where an observation could be made, were properly restrained. Generally, there were between one and two children in the car. Most drivers had commutes of 20 minutes or less and did not travel at highway speed while commuting. Children transported spent less than 3 hours per week in the car outside of the daily commute.

There were no specific determinants of catastrophic use identified. Driver seat belt use, the amount of travel per week with children, the speed of travel, and whether or not drivers had consulted with a health professional did not appear to differ based on the identification of catastrophic use. Driver gender, age and relationship to the child being transported also did not differ. These findings differ from previous research that suggests there are specific determinants of incorrect child restraint use (Bracchitta, 2006; Cameron, Segedin, Nuthall & Thompson, 2006; Ebel et al., 2003; Koppel, Charlton, Fitzharris, Congiu & Fildes, 2008). Other potential determinants of catastrophic use not assessed in this study include socioeconomic status and the level of child restraint enforcement in the area.

Knowledge of age and weight guidelines for graduation from one type of child restraint to another was not a barrier to correct use. Potential barriers reported by drivers, regardless of whether there was catastrophic use observed, included a lack of awareness of their own misuse, the child's behaviour, and the fit of the seat with winter clothing. These factors have also been identified in other studies (Bracchitta, 2006; Cameron et al., 2006; Ebel et al., 2003; Koppel et al., 2008).

Legally correct seat choice determined using the current Alberta legislation for child restraints was compared to best practice to provide a broader context for understanding the implications booster seat legislation. Seat belts, based on current Alberta legislation, were the legally correct choice for the majority of children observed to be riding in them. But best practice, based on research that takes into account age and weight, suggests that only a minority of the children in seat belts were in the appropriate choice.

Alarmingly, there was at least one catastrophic use observed for almost all of the children in seat belts when analyzed by legislation. This result corresponds to findings from previous studies that suggest high rates of premature graduation to adult seat belts (Cameron et al., 2006; Ebel et al., 2003; Lee, Shults, Greenspan, Haileyesus & Dellinger, 2008**;** Snowdon et al., 2009; Visentini &

Willems, 2007). Catastrophic uses observed were related to the fit of the belt across the hips and the chest, suggesting that the children may have been more appropriately restrained in a booster seat. Booster seats are designed to raise a child up so that the seat belt crosses the body at the intended points.

The majority of children observed to be riding in booster seats, forward facing and rear facing seats were in the appropriate child restraint based on both legislation and best practice. Some catastrophic use was observed, particularly with forward facing seats. The most common catastrophic use was that tether anchor was not used. Similar results were observed by Duchossis, Nance & Wiebe (2008). Tether strap use is mandatory for forward facing seats. The subjective experience of drivers in this study suggests that tether straps may be difficult to use, and that there may be some confusion between tether straps and the UAS system.

A loose shoulder harness was a catastrophic use that was observed in both forward facing and rear facing child restraints. Drivers reported that harnesses were sometimes difficult to use, and that children's clothing also made it difficult to use correctly. Driver responses also reflected that they did not always recognize that a tight harness was important in keeping their child secure.

Although catastrophic use with booster seats was rare, in a handful of cases it was observed that the shoulder belt did not cross the child's chest, suggesting that the child may have been too short for a booster. Previous research has found comparable findings suggesting that a misplaced shoulder belt is the most commonly observed misuse for children in booster seats (Cameron et al., 2006). Current booster seat recommendations focus on age and weight, but the correct fit of the booster seat requires that height also needs to be considered. A child may meet the age and weight criteria for a booster seat but could have a short stature and may not be tall enough to have the seat belt cross the body at the chest (Durbin, Elliot & Winston, 2003).

Implications of the Results

While the results must be interpreted with caution, they can be used to formulate strategies to increase proper child restraint use and decrease the number of motor vehicle related injuries to children.

Children in Booster Seats

The results suggest that increasing booster seat use would better protect children who have outgrown forward facing child restraints. The importance of height in addition to age and weight as aspects of fit and correct use were also highlighted. Booster seat legislation has been shown to increase booster seat use (Farmer, Howard, Rothman & MacPherson, 2009; Snowdon et al., 2009) and research suggests that booster seat legislation should be supplemented by education and awareness campaigns (Koppel et al., 2008).

<u>Implications for Action</u>

- Pursue definitive booster seat legislation in Alberta.
- Supplement this booster seat legislation with education and awareness campaign to help parents understand correct use and fit of booster seats. Include height, weight, as well as age in education and awareness campaign materials, in addition to information about the new law.

Children in Rear and Forward Facing Seats

The results suggest that the combination of legislation and educational efforts with parents of children in rear and forward facing seats have been effective in protecting children under 40 lbs (18kg) or 6 years old. Parents are, for the most part, knowledgeable about child restraints and how to use them correctly, and access information about child restraints from a variety of sources. Parents knew what the correct seat choice was for their children and showed relatively low levels of catastrophic use.

Implications for Action

- Target educational efforts on those aspects of fit that, if incorrect, will be catastrophic or life-threatening in a collision. Parents of young children receive many messages regarding safe use of child restraints and about keeping their children safe in a variety of other situations. The volume of these safety messages can be overwhelming. Educational messages need to be strategic and must target the areas that are most critical. Child restraint messages need to focus on the misuses that would most likely be catastrophic or life threatening in a collision.
- It is also necessary to support professionals who work with parents to adopt this targeted approach so that parents are consistently receiving the critical messages as a priority.
- Based on the results of this study, targeted education efforts should focus on:
    - Tether straps for forward facing child restraints – include the importance of the tether strap, how it differs from UAS, and that tether straps are mandatory
    - Tight shoulder harness – include the importance of ensuring the harness is snug, and tips for tightening the shoulder harness.

Areas for Additional Research

- Continued surveillance of correct child restraint use at a variety of locations beyond schools and daycares to ensure that the diversity of Albertans is represented.
- Evaluation of strategies to increase correct child restraint use.
- Further identification of barriers to correct use including the range of Albertans and methods to overcome these barriers.

References

Arbogast K.B., Kent R.W., Menon, R.A., Yoganand MS., Dennis R., Rouhana S. (2007). Mechanisms of abdominal organ injury in seat belt-restrained children. *The Journal of Trauma, Injury, Infection and Critical Care, 62*(6), 1473-1480.

Bracchitta K.M. (2006). Factors influencing parental use of booster seats for their children. *Journal of Clinical Psychology in Medical Settings, 13*(3), 273-284.

Cameron L., Segedin E., Nuthall G., & Thompson (2006). Safe restraint of the child passenger. *Journal of Paediatrics and Child Health, 42*, 753-757.

Decina L.E., Temple M.G. & Dorer H.S. (1994). Increasing child safety-seat use and proper use among toddlers: Evaluation of an enforcement and education program. *Accident Analysis and Prevention, 26*(5), 667-673.

Duchossis G.P.,c Nance M.L., & Wiebe D.J. (2008). Evaluations of child safety seat checkpoint events. *Accident Analysis and Prevention 40,* 1908-1912.

Durbin D.R. Arbogast K.B., & Moll E.K. (2001). Seat belt syndrome in children: A case report and review of literature. *Pediatric Emergency Care, 17*(6), 474-477.

Durbin D.R., Elliott M.R., & Winston F.K. (2003). Belt-positioning booster seats and reduction in risk of injury among children in vehicle crashes. *Journal of the American Medical Association, 289*(21), 2835-2840.

Ebel B.E., Koepsell T.D., Bennett E.E., & Rivara F.P. (2003). Too small for a seatbelt: Predictors of booster seat use by child passengers. *Paediatrics, 111*, e3232-e327.

Elliot M.R., Kallan M.J., Durbin D.R., & Winston F.K. (2006). Effectiveness of child safety seats vs seat belts in reducing risk for death in children in passenger vehicle crashes. *Archives of Pediatric Adolescent Medicine, 160*(6), 617-621.

Farmer P., Howard A., Rothman L., & Macpherson A. (2009). Booster seat laws and child fatalities: A case control study. *Injury Prevention, 15*, 348-350.

Gunn V.L., Phillippi R.M., & Cooper W.O. (2007). Improvement in booster seat use in Tennessee. *Pediatrics, 119*, e131-e136.

Koppel S., Charlton J.L., Fitzharris M., Congiu M., & Fildes B. (2008). Factors associated with the premature graduation of children into seatbelts. *Accident Analysis and Prevention,* 40, 657-666.

Lee K.C., Shults R.A., Greenspan A.I., Haileyesus T., & Dellinger A.M. (2008). Child passenger restraint use and emergency department-reported injuries: A special study using the National Electronic Injury Surveillance System—All injury Program, 2004. *Journal of Safety Research, 39*, 25-31.

Lutz N., Arbogast K.B., Cornejo R.A., Winston F.K., Durbin D.R., & Nance M.L. (2003). Suboptimal restraint affects the pattern of abdominal injuries in children involved in motor vehicle crashes, *Journal of Pediatric Surgery, 38*(6), 919-923.

Public Health Agency of Canada (2009). *Child and youth injury review*. Ottawa Ontario

Safe Kids Canada (2004a). *Booster seat use in Canada: A national challenge*. Toronto, Ontario.

Safe Kids Canada (2004b). *Child and youth unintentional injury: 10 years in Review 1994-2003*. Toronto, Ontario.

Snowdon A., Rothman L., Slater M., Kolga C., Hussein A., Boase P., & Howard A. (2009). A comparison of booster seat us in Canadian provinces with and without legislation. *Injury Prevention, 15*, 230-233.

Visentini L., & Willems B. (2007). Premature graduation of children in child restraint systems: An observational study. *Accident Analysis and Prevention, 29*, 867-872.

Winston F.K., & Durbin D.R. (1999) Buckle Up! Is not enough: Enhancing protection of the restrained child. *Journal of the American Medical Association, 281*(22), 2070-2072.

Winston F.K., Kallan M.J., Elliot M.R., Dawei X., & Durbin D.R. (2007). Effect of booster seat laws on appropriate restraint use by children 4 to 7 years old involved in crashes. *Archives of Pediatric & Adolescent Medicine, 161*, 270-275.

World Health Organization. (2009). *Weight for age growth standards.* Retrieved December 23, 2009, from http://www.who.int/childgrowth/en/.

Zaza S., Sleet D.A., Thompson R.S., Sosin D.M., & Bolen J.C. (2001) Reviews of evidence regarding interventions to increase use of child safety seats. *American Journal of Preventative Medicine, 21*(4 supplement), 31-47.

Appendix A: ACRES Data Collection Forms

ACRES Data Collection Form - Driver

1. OBSERVED VEHICLE #: ____

2. Driver chooses to participate: yes no

Collect for all vehicles

3. # in vehicle under 9 yrs: (record) ____

4. Vehicle type: (circle one) Car SUV Van/Minivan Pick-up Truck

5. Location of children in vehicle: (circle all that apply)

Front of Vehicle			
3	6	9	Cargo Area
2	5	8	
D (Driver)	4	7	

6. Driver gender: (circle one) M F

7. Driver age: (circle one) under 20 20's 30's 40's 50's 60's 70+

8. Driver properly restrained in seatbelt: (circle one) yes no don't know

Collect for non-participants if possible

9. Reason for non-participation? (circle and/or record)
- **a.** not enough time
- **b.** didn't say
- **c.** other

10. Comment on apparent restraint use (circle one)
- **a.** all children in vehicle restrained properly
- **b.** some improper restraint use was observed in this vehicle
- **c.** not sure

11. Additional information on non-participating driver (record)

12 .Year / make / model: (record) _____

13. Driver Relationship: (circle all that apply)
parent grandparent caregiver carpool other family member _____

14. What is the average length of time of your commute from here to home?
(record) ____ **min**

15: Will you be traveling at highway speed? yes no

16. How many hours per week, outside of the commute, are your children in a vehicle? ____ **hrs**

17. Where do you get your information on car seats? (circle all that apply)
a physician **b** public health nurse **c** other parents **d** vehicle owners manual
e CRS instruction manual **f** police officer or fire fighter **g** traffic safety website
h none **i** others _____

18. Where do you think parents should get information on transporting their child safely? (record) _____

19. Did you know there is a fine in Alberta for child restraint misuse?: yes no

20. Do you know what are the age and weight guidelines to move a child from a:
- **a. Rear facing to forward facing?** ***Did they know 20-22lbs or at least 1y?:*** yes no
- **b. Forward facing to booster seat?** ***Did they know 40lbs or at least 6y?:*** yes no
- **c. Booster seat to seatbelt?** ***Did they know 80lbs or at least 9y?:*** yes no

Inspector will now inform driver of what they have found and point out any errors. Record any important and relevant drivers responses below

21.

22. Any other common problems or frustrations you have regarding the use of your child restraints. (record)**:**

Need to be in a rear facing until they are at least 20-22 lbs (1)
Need to be in a forward facing seat between 20lbs until 40lbs (1-5)
Recommended they be in a booster between 40 and 80lbs (6-8)
Recommended they not use a seat belt until 80lbs (9 years)

Town/City:
Location Name:

Target Group:

ACRES Data Collection Form - Child

1. **OBSERVED VEHICLE #:** ____

INSPECTOR

Age / Weight (specify months or years / lbs or kgs)	____ mo / yr ____lbs / kg	____ mo / yr ____lbs / kg	____ mo / yr ____lbs / kg
Restraint used (refer to Restraint Types below)	A B C D E F	A B C D E F	A B C D E F
Seating Location (refer to diagram)	_____	_____	_____
If UAS equipped, is it being used?	YES NO	YES NO	YES NO

	Restraint Type: A (Seatbelt) **or D** (Booster Seat)										
→	**1** Is the seatbelt being used?	**1**	Y	N**		**1**	Y	N**		**1**	Y	N**	
	2 Does the seatbelt have a shoulder strap?	**2**	Y	N		**2**	Y	N		**2**	Y	N	
	3 Is the seatbelt tight?	**3**	Y	N		**3**	Y	N		**3**	Y	N	
→	**4** Is the shoulder belt across the chest?	**4**	Y	N **		**4**	Y	N **		**4**	Y	N **	
	5 If **NO**, where is it?	**5**	arm	back		**5**	arm	back		**5**	arm	back	
→	**6** Is the lap belt low on the hips?	**6**	Y	N **		**6**	Y	N **		**6**	Y	N **	

	Restraint Type: B (FF Child Seat) **or C** (RF Child Seat)										
	1 Is the shoulder harness at the correct height?	**1**	Y	N		**1**	Y	N		**1**	Y	N	
	2 Is the chest clip level with armpit?	**2**	Y	N	NA	**2**	Y	N	NA	**2**	Y	N	NA
→	**3** Is the harness snug?	**3**	Y	N **		**3**	Y	N **		**3**	Y	N **	
→	**4** Seat belt or UAS used?	**4**	Y	N **		**4**	Y	N **		**4**	Y	N **	
	5 Is the seat belt or UAS routed correctly?	**5**	Y	N		**5**	Y	N		**5**	Y	N	
→	**6** Is the seat facing the correct direction?	**6**	Y	N **		**6**	Y	N **		**6**	Y	N **	

	Restraint Type: B only (FF Child Seat)										
	1 Tether anchor available?	**1**	Y	N	unknown	**1**	Y	N	unknown	**1**	Y	N	unknown
→	**2** Tether anchor used?	**2**	Y	N **		**2**	Y	N **		**2**	Y	N **	

Is this child properly restrained?	YES NO	YES NO	YES NO
If NO, for what reasons? (circle all that apply)	seat choice / seat install / seat use	seat choice / seat install / seat use	seat choice / seat install / seat use
Additional comments			

RESTRAINT T YPES

A: Seat Belts
B: Forward Facing CRS
C: Rear Facing CRS
D: Booster Seat
E: Unrestrained
F: Other

3	6	9	Cargo Area
2	5	8	
D (Driver)	4	7	

**** Identifies any misuse or using the wrong seat for the child's weight -- MUST be explained to the driver.**

Appendix B: Overview of Steps Used to Arrive at Child Sample