

This item was submitted to [Loughborough's Research Repository](#) by the author.  
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

## **Analysis of CREST and CHILD accident data related to side impacts**

PLEASE CITE THE PUBLISHED VERSION

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Lesire, Philippe, Veronique Herve, and Alan Kirk. 2019. "Analysis of CREST and CHILD Accident Data Related to Side Impacts". figshare. <https://hdl.handle.net/2134/2624>.



4th International Conference « Protection of children in cars »  
Munich - 07th & 08th of december 2006



## **Analysis of CREST and CHILD accident data related to side impacts**

Philippe LESIRE (LAB) – Véronique HERVE (CEESAR) – Alan KIRK (VSRC)



## Definitions 1/2

- ▶ **CHILD:** occupant of car with age under 12 years
- ▶ **RESTRAINED:** using a restraint system (incl. inappropriate)
- ▶ **APPROPRIATE:** restraint system used is approved for his weight / height (or age) of the child
- ▶ **CRS:** Child restraint system (additional or integrated)



## Definitions 2/2

▶ **MISUSE**: use of CRS not according to user manual instructions



▶ **SHELL SYSTEMS**: CRS designed to be used with a harness or a shield (rearward facing or forward facing)

▶ **STRUCK SIDE**: the side of the car on which the main impact occurred during the crash



▶ **DIRECT INTRUSION**: the occupant is in the area where the car sustained deformations after contact with an object or another vehicle.



## Sample size

287 restrained children in side impacts

100 – adult seatbelt

187 – additional CRS

164 on the struck side

122 on the non struck side or center seat

1 with position unknown



## Quality of sample

**Weight :** 42%

**Type of CRS:** 99%

**name of CRS:** 79%

**Maximum intrusion value** (measured or evaluated):

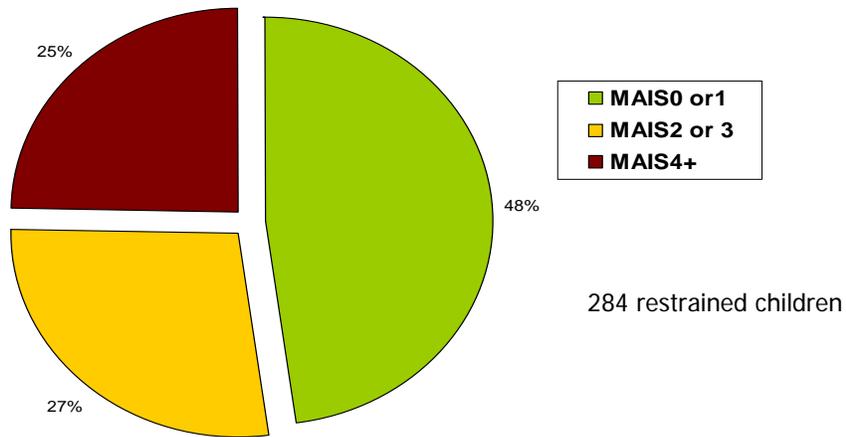
all side impact cases except 1

**Injury severity :** all children except 3.

The sample for analysis is then 284 children

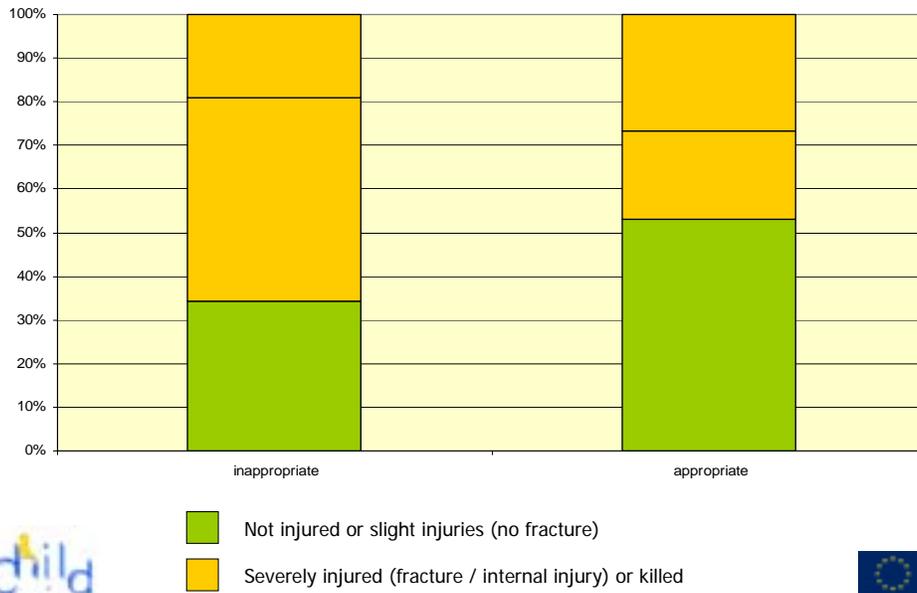


## OVERVIEW – injury severity



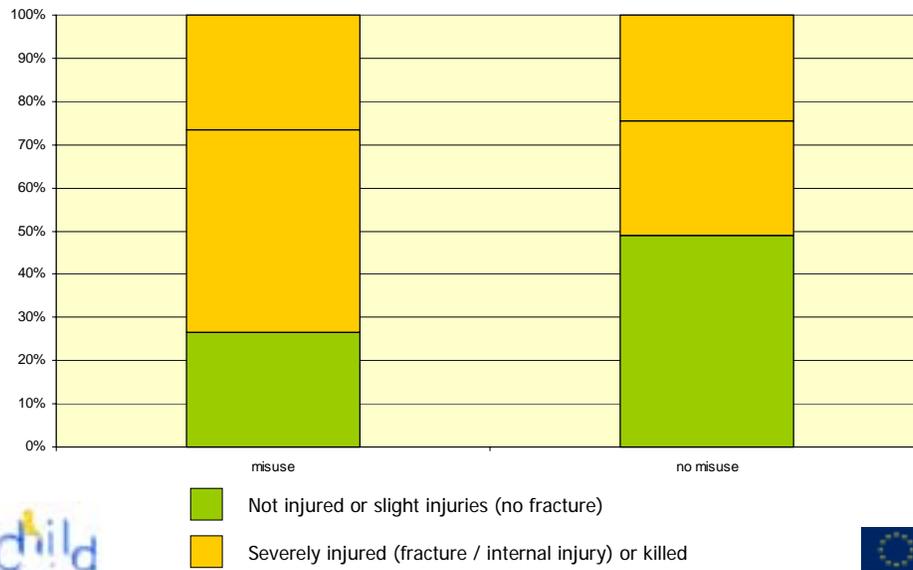
Half of the children of the sample were not injured or sustained minor injuries, a quarter sustained moderate injuries and the last quarter were severely or fatally injured. The reasons to use this repartition (0-1; 2-3 and 4+) is due to the coding of injuries considered as severe but only scoring at AIS2 value for occupants under 12 years of age. If lower limbs fracture are excluded it would change the global figures of the following analysis.

## Influence: appropriate use



Clear influence on the slightly injured children of using an appropriate use (more than 50% safe versus 35% only for inappropriate). This is not visible for severe injury level because of the criteria on severity to have a case accepted (interest of cases with injuries)

## Influence: misuse



## Influence: other items



### -type of car:

-due to our selection criteria, no significant differences on injury severity for restrained children according to different types of cars



### -side airbags:

-only 5 children seated on the struck side had a head or side airbag deployed. None of them has a M.AIS superior than 3.



-no conclusion: more data needed



Everything is on the slide

## Analysis per loading type

### **-SIDE SWIPE**

9 restrained children



### **-LATERAL on the STRUCK SIDE**

157 restrained children



### **-LATERAL on the NON STRUCK SIDE**

120 restrained children



## Side swipe

### **-SIDE SWIPE**

7 accidents - 9 restrained children

### **-Tendency :**

4 - without direct intrusion: M.AIS 0 or 1

5 – with intrusion: M.AIS 4 or 5

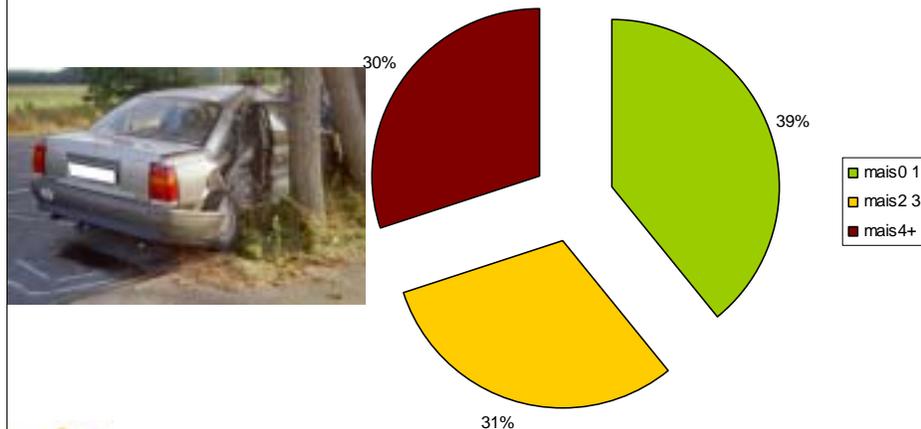
with head / brain injuries for all of them

**MOST PROBABLE INJURY MECHANISM  
IN SIDE SWIPE:** direct impact of the head  
against the opposing intruding object.



## Struck side: injury severity

General : 157 children

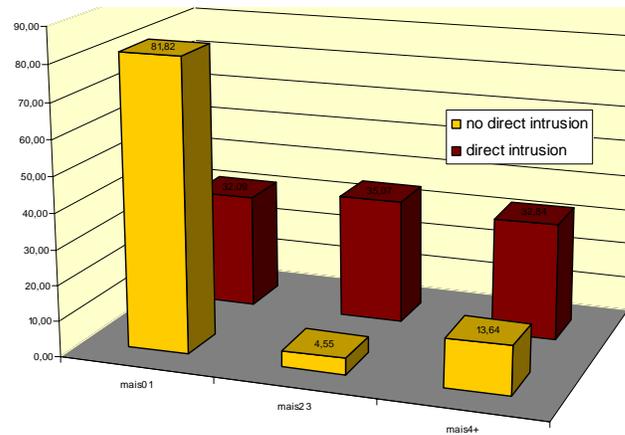


The distribution of injury severity is different than for the global sample. Here only 40% of children are slightly injured or not injured, while 30% of them are moderately injured and the 30% remaining suffered of serious or fatal injuries. This shows that the fact of being on the struck side is globally more dangerous.

## Struck side: influence of intrusion

-22 children without direct intrusion at child's seating position (mean value of maximum intrusion is 470 mm)

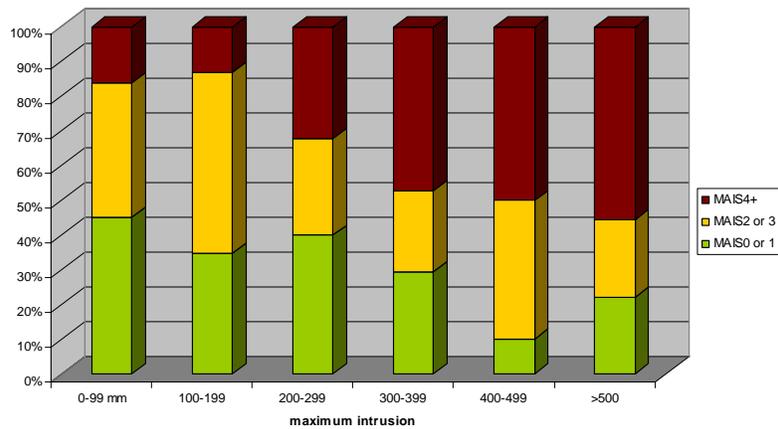
-134 with direct intrusion - (mean value of maximum intrusion is 463 mm)



Intrusion have a direct influence on the injury severity for children. 81% of restrained children on the struck side without direct intrusion receive no or no severe injuries and less than 14% receive serious injuries. For those who sustained direct intrusion, the situation is different, 1/3 is not or slightly injured, 1/3 received moderate injuries and 1/3 are seriously or fatally injured.

## Struck side: intrusion value

-134 on struck side with direct intrusion



The value of the maximum intrusion for the car has a direct link with the level of injury severity for children on the struck side in the area of the intrusion. Over 300 mm of maximum intrusion, more than 50% of restrained children in these conditions are M.AIS 4+.

## Struck side: intrusion – CRS type

-Shell systems (forward or rearward facing)

50 children sustaining 57 injuries AIS2+

**Ratio: 1.14**

-Booster seats and booster cushions

35 children sustaining 70 injuries AIS2+

**Ratio: 2.0**

-Adult seatbelts

49 children sustaining 111 injuries AIS2+

**Ratio: 2.27**

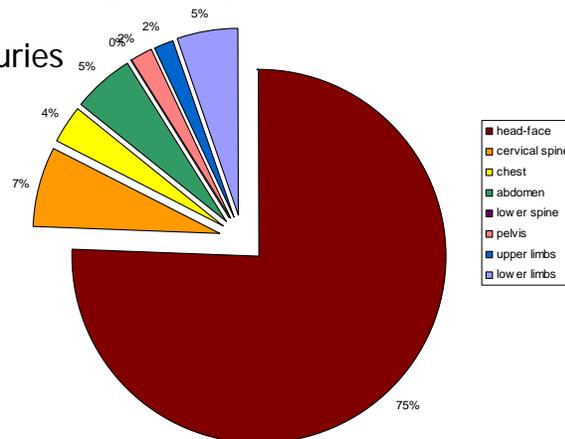


The risk of sustaining AIS2+ injuries is two times higher for children only restrained by the adult seatbelt than the ones restrained in shell systems.

## Struck side: intrusion – CRS type

- Shell systems (forward or rearward facing)
- 50 children sustaining 140 injuries (all severities).

AIS2+: 57 injuries

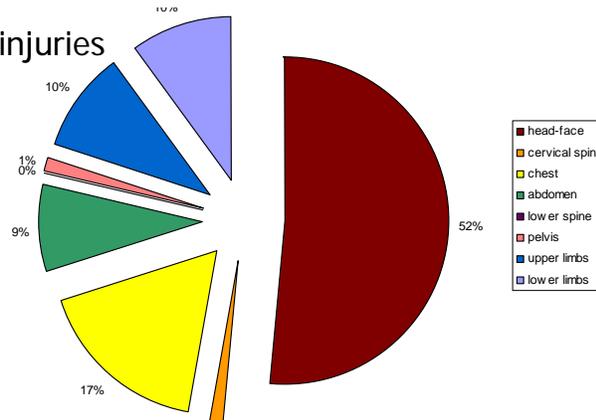


$\frac{3}{4}$  of moderate and severe injuries occur to the head/face for children restrained in shell systems. The neck is representing the second body regions injured and often lead to fatality of the child or permanent invalidity. The relation with head contact was not possible to establish. The cervical spine remains an important body region to be protected for children in age of being in shell systems (0-4years). Abdomen and chest are then coming, with no fracture of the rib cage but compression of the chest or of the abdominal area in the shell. No lumbar spine injuries and very few pelvis fracture with these systems. Lower limbs represent a relative important part of severe injuries.

## Struck side: intrusion – CRS type

-booster seats and booster cushions  
35 children sustaining 147 injuries (all severities).

AIS2+: 70 injuries



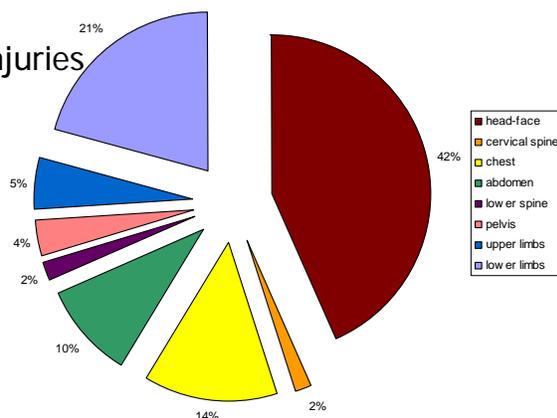
The head remains the bigger part of severe injuries occurring to children when restrained in booster seats and booster cushions, with a little bit more than 50%, the chest goes up to 17% still without fractures of the rib cage but because of the compression of the chest, abdominal area is still around 5% and both upper (humerus and clavicle) and lower limbs are scoring approximately 10% each.

## Struck side: intrusion – CRS type

-Adult seatbelt

49 children sustaining 209 injuries (all severities).

AIS2+: 111 injuries



The percentage of head injuries is decreasing to 42%, the percentage on chest injuries is still going up and scores 14% with half of these injuries as lung contusion, some other as hamothorax and the first rib cage fractures appears due to a less compliant rib cage (combined the fact that in normal restraint use, these children are heavier than the ones using boosters). Pelvis fractures also start being seen but not so frequent. Clavicles fracture are not rare and lower limb fractures represent a high percentage of serious injuries.

## Struck side: injury causation

- **HEAD** : impact on rigid part of car (direct or through CRS)
- **CERVICAL SPINE** : not clearly defined (often associated with brain haematoma)
- **CHEST** :
  - Shell: Compression of the chest inside of the shell
  - Boosters : compression due to door panel contact
  - Seatbelt: rib fractures + internal organs injuries



## Struck side: injury causation

- **ABDOMEN** : intrusion of door panel
- **PELVIS**: some fractures (boosters or seatbelts)
- **UPPER LIMBS**: Shoulder impacts - doorpanel
- **LOWER LIMBS**: to be further investigated



## Non struck side: injury repartition

- **HEAD** : impact on rigid part of the car
- **CHEST** : no fracture, mainly lung contusions due to impact with door panel or interaction with another occupant.
- **PELVIS** : some fractures, mainly due to occupant interaction.
- **other body regions** : the size of the sample do not allow the definition of injury causation.



## Side impact : conclusions

### CREST / CHILD ACCIDENT DATABASE

This analysis has shown:

- positive effect of CRS use on child protection,
- influence of the maximum intrusion value,
- negative influence of misuse and inappropriate use
- body segments to be protected in priority per type of restraint:
  - Head/face (impact), chest for all types of restraint used,
  - Neck for children under 3 y (shell systems),
  - Abdomen & pelvis (boosters and seatbelt)
- side impact is still a real concern in terms of child protection  
(CRS mainly designed for protection in frontal impact)



## ACKNOWLEDGEMENTS

- CREST & CHILD ACCIDENT INVESTIGATION TEAMS
- CHILD consortium
- CCIS – source of some cases
  
- This presentation will be posted on CHILD website

[childincarsafety.com](http://childincarsafety.com)

THANKS FOR YOUR ATTENTION

